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Cost Forecasting and Programme Management Study

Final Report

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1 Introduction

1.1 Objectives

This Final Report draws together the main results from the data collection, analyses, conclusions and recommendations from the Study. The individual country reports provided to each managing authority give country specific information and report on the construction cost and programme management performance of each country compared to the other participating countries.

This Final Report is intended, whilst preserving anonymity, to provide an overview covering all the tasks with the exception of the Workshops (Task 3) which have been held to disseminate information and collate feedback on the country reports and are reported upon separately[1].

1.2 Study Scope

The scope of the Study is defined in terms of participating countries (EST, LAT, LITH, POL, SK, CZ, SI, ROM and BUL), sectors (all nine countries elected to participate in the roads sector and seven countries (EST and SI excluded) in rail) and tasks. Initially HU was participating, but was later replaced by CZ. The tasks are grouped into modules and the country participation in each module is set out in Table 1.1. A schematic of the tasks, showing the main inter-relationships is set out in Figure 1.1 below.

Table 1.1: Participants in each Module

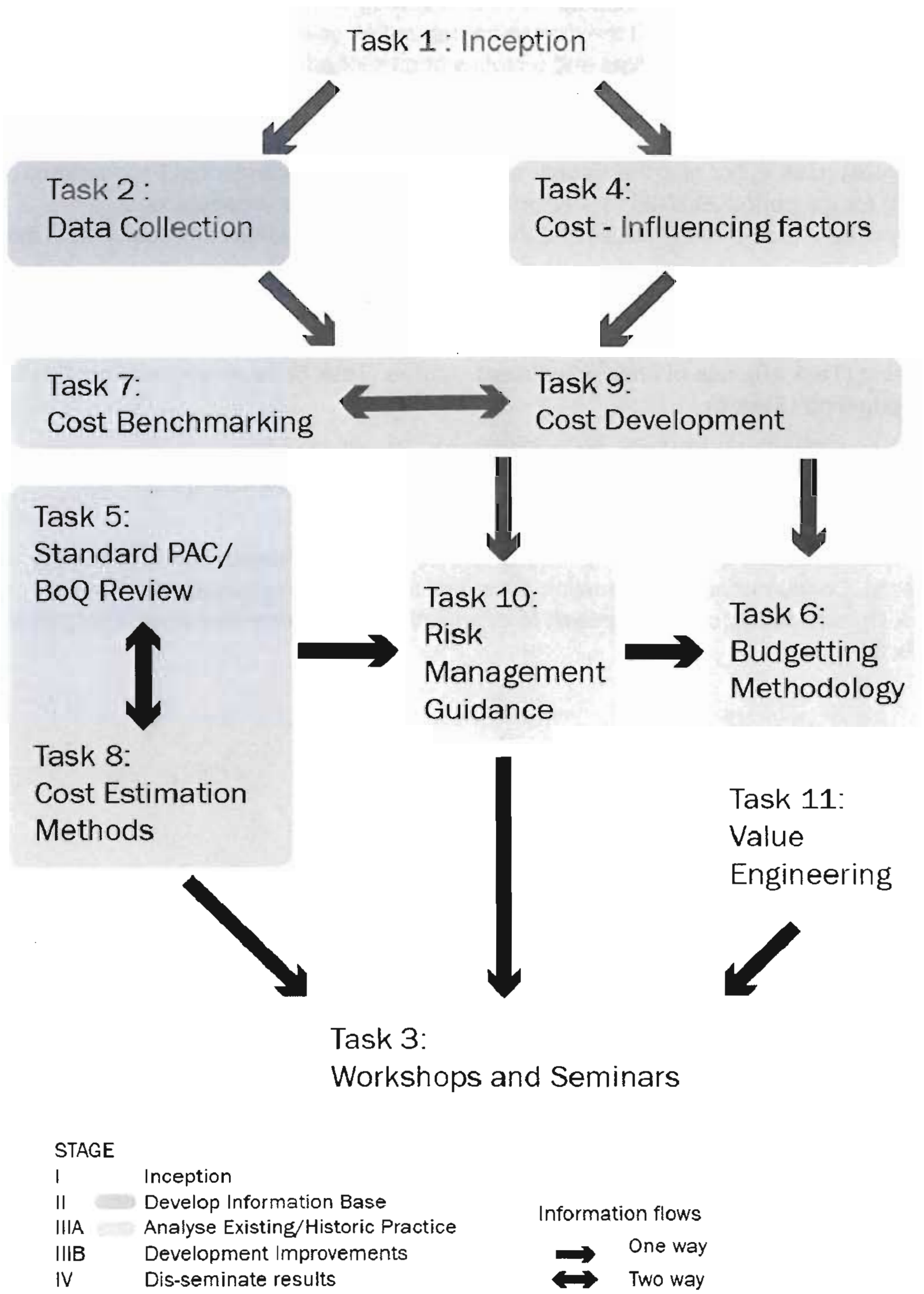
Country	Abbreviation	Module 1	Module 2	Module 3	Module 4	Module 5
Bulgaria	BUL		✓	✓	✓	✓
Czech Republic	CZ	✓	✓	✓	✓	
Estonia	EST		✓	✓	✓	
Latvia	LAT		✓	✓	✓	✓
Lithuania	LTH	✓	✓	✓	✓	✓
Poland	POL		✓	✓	✓	
Slovenia	SI		✓	✓	✓	
Slovakia	SK	✓	✓	✓	✓	
Romania	ROM	✓	✓	✓	✓	✓

[1] A full list of the all the reports and databases available from the study is set out at Appendix A.

Table 1.2: Tasks in Each Module

Module	Task Number	Task Name
1	4	Market Context
	5	Use of Price Adjustment Clause
	6	Budgeting Process
2	7	Cost benchmarking
3	8	Cost Estimation
4	9	Cost Development
	10	Risk Management
5	11	Value Engineering

Figure 1.1 Methodology Overview



1.3 Layout of Report

The focus of the Study is on the management of road and rail construction costs over the length of the project cycle. This requires an understanding of the market context in which the road and rail beneficiaries and the managing authorities operate, an assessment of performance in terms of output costs and a review of current practices. Based on the results of these activities, conclusions are made and recommendations are given.

Context and performance are presented first, in Chapter 2. Context relates not only to market context (task 4) but also the targets and rules set by the Operational Programmes (Transport) for the period 2007-2013. Performance divides into two aspects: cost development over project life (Task 9) and the benchmarking of outturn unit costs/km (Task 7).

The review of current practice in Chapter 3 seeks to explain how activities and procedures may have influenced performance. The activities reviewed are cost estimation (Task 8), risk management (Task 10), use of price adjustment clauses (Task 5) value engineering (Task 11) and budgeting (Task 6).

Conclusions and recommendations are in Chapter 4. Specific recommendations, using good practice as a benchmark, based on the evidence from Chapter 2 and observed practice (from Chapter 3) are then set out.

The appendices include a list of all the reports and databases produced during the Study (appendix A), Consumer and Construction price indices in the participating countries (Appendix B), and details of our approach to quantitative risk assessment and contingencies (Appendix C).

2 Context and Outturn Performance

2.1 Market Context

2.1.1 Introduction

The context within which the road and rail sectors operate in each of the participating countries can be considered in terms of fixed factors (upon which the countries have no control) and broad economic and political factors determined at national and international level.

Road and rail sector policies operate within this context. The combination of these wider factors can influence how hard the managing authorities and beneficiaries may have to work to construct and maintain the road and rail networks in a manner which is judged to deliver investment programmes which represent good value.

The country studies provide evidence of a range of factors contributing to the wider economic environment influencing road and rail construction prices. It should be noted that this refers to the period 2000-2008/2009 and therefore mainly precedes the current economic crisis. Consumer price indices show average annual inflation rates of between 3 and 5% in seven of the nine countries with only two showing higher rates (LAT 7% and ROM 12%).

However it is the difference between consumer price inflation (CPI) and construction inflation (CI) which is a more relevant indicator of the success each country is having in controlling real construction prices. These indices are reported in Appendix B. Taking the year of greatest divergence between these two indices as an indicator, there are four countries (SI, SK, CZ and POL) where the difference between the two indices has been low, four where the gap could be said to be moderate (maximum ratios of CI/CPI of between 1.17 and 1.39) and one country (BUL) where construction prices have grown significantly faster than consumer prices (ratio 2.33).

2.1.2 Possible Explanations

2.1.2.1 Fixed Factors

Two sets of so-called fixed factors which may have a bearing on trends in the road and rail sectors are (i) construction market size and (ii) geographic location/centrality. Larger countries are likely to require and contract larger volumes of road and rail construction work each year - offering the prospect for the supply side to mature and develop with greater competition for work than in smaller countries. The larger central countries are more likely to be attractive to foreign construction companies and conversely, peripheral countries may be slightly less attractive. Thus, as a broad generalisation, large central countries may benefit from external conditions more favourable to supply side competition, increasing efficiency and driving down prices than small, peripheral economies where the challenges posed by the external environment may be greater.

2.1.2.2 Cross-sector Policy Related Factors

At a broad policy level (that is above the road and rail sector specifics such as costing methods and risk management), the country analyses have identified a number of policy related factors which can influence construction costs. Prominent amongst these is the *presence of foreign contractors* which is said to be high in some countries (CZ) and encouraged in others (LITH). In contrast, in some other countries (BUL, LAT, SK) the complexity of legislation and procurement procedures, including language barriers (unwillingness to publish tender documents in English) and a high allocation of contractor risk, has led to a reported lack of international contractors. In other countries (ROM, BUL) there has been a high turnover of such contractors with several failing to win sufficient work to stay in country, for a variety of reasons (corruption is still believed to exist and this, coupled with a unstable political environment, a complex legal framework and increasing tendency to advertise in Romanian language continues to deter foreign companies).

In some countries (EST, LITH, POL) *labour shortages* have been cited as contributing significantly to construction cost increases[2]. It may be that country size is relevant here, where, if the flow of construction contracts cannot be managed to provide a year-on-year even workload, the construction sector may be more exposed to stop-start effects of the economic cycle.

The success of policies aimed at *wider macro-economic management* has clearly had bearing on the evolution of construction costs during the 2008-2010 recession, especially in those countries (LAT, LITH, ROM, BUL) where problems have been especially acute[3]. Significant real cost reductions have been observed as contractors have cut prices dramatically in efforts to win shares of a reduced market for work. In one country (LAT) these effects will certainly dominate any other factors seeking to explain construction cost developments over this period.

In other countries (ROM, BUL), weak Employer capacity is cited as a key reason for construction cost increases. This can be traced to relatively low public sector salaries and weak legal and institutional frameworks. These weaknesses affect the quality of management of design, contract award, supervision of works and overall project management. BUL: Almost all road projects experienced large increases in costs from contract award to project completion, suggesting that project management needs to be tighter.

OP Transport may cause over heating. In two countries (EST, SI) construction inflation is expected to be a real challenge in future and when money is distributed from EU funds for large scale infrastructure projects.

2.1.2.3 Road and Rail Sector: Policy Influences

It is against this background that the Managing Authorities and beneficiaries set policies, practices and standards which can influence road and rail sector cost development. Attitudes and practices which *can* be subject to change include cost estimation methods, choice of contract types (including the use of PAC) and (as an underling process through the project cycle) risk management. The next sections of this chapter present the project-specific evidence collected on cost development and (between-country) benchmarking of costs. This evidence completes the background to the presentation, in chapter 3, of current practice. The recommendations, in chapter 4, set out a menu of options to be considered by the managing authorities and beneficiaries featuring measures through which practices might be improved.

2.1.2.4 Factors Specific to the Road Sector

The Estonian road sector is an exception to the generalisation suggested above that there may be less competition in small peripheral compared to larger central economies. Estonia is the most northern of the three Baltic states, and yet has almost thirty domestic road works contractors and should be well located to encourage more Scandinavian, particularly Finnish, companies.

In the Latvian road sector, the analysis (up to 2008) suggests modest levels of competition between local contractors but little international interest. Limited market and contract size, barriers to entry and advertising in local language have contributed to limiting interest in the roads market.

Contract/Lot size: (SK, LAT, SI): Contracts tend to be relatively low value and contract documentation is published only in the local language, meaning that bids tend to come from local companies. In contrast (CZ): Motorway and major rail modernisation contracts tend to

[2] Labour shortages resulting in low unemployment appear to have been a major factor in the high level of construction inflation in one country (LIT) in recent years.

[3] In the period 2005-2008, one country (LAT) experienced a rapid growth in consumer prices (about 10 per annum) but an even more rapid increase in construction cost inflation with an increase over three years, of about seventy per cent. Since 2008 there has been a collapse in the construction market with 2009 tender prices at some two thirds (or a lower proportion of 2003 levels). Labour costs (and profit) can be seen to be the main sources of this growth rather than material costs.

be carried out only by large construction companies due to the size of the contracts, with medium and small companies being involved only as subcontractors.

2.1.2.5 Rail Sector Structural Factors

Railway projects are developed in a different way to road projects, in both Western and Eastern Europe and in most other parts of the world, because of the different nature of the rail sector. Brand new rail routes (usually High Speed Lines) in France, UK, Italy, Germany, Netherlands and Spain have generally been tendered by central government to a private venture by consortium in much the same way as major motorway projects. Usually the consortium takes the agreed route and carries out all design and construction works, either handing the completed project over to the national railway infrastructure provider, or operating it on a toll fee basis.

However, there are at present no such high speed lines in Eastern Europe. Here all rail projects are for the refurbishment, rehabilitation or upgrade of existing routes, normally to bring TEN-T routes up to the requirements of the Technical Standards of Interoperability set by the European Railway Agency. This work is carried out on live operational railway, usually on the busiest and most important route corridors of the member state concerned.

Traditionally, all European railways were state concerns, either under full nationalised control, or in some countries, nominally private companies that are part or wholly owned by national or regional government and substantially funded by them. These traditional organisations had all the technical resources (design and construction) required to design and construct upgrade projects, as a supplement to their normal maintenance and renewal activities. In Eastern Europe the railway also performed a wider social role, often providing healthcare and education facilities. As part of this, a number of state higher education institutes, specialising in railway engineering, were established, usually under railway ownership and control. These Design Institutes doubled as the project designers.

Since accession to the EU, this organisational structure has been largely broken up as part of the restructuring process to bring the railways into line with the requirements of the railway legislation. Much of this traditional source of expertise and resource has therefore disappeared.

Railway projects therefore take place on operational infrastructure and the initial project scoping is almost always carried out by the railway Infrastructure Manager (IM), normally a state owned body. This scoping should, and normally does, consist of:

- A review of asset condition
- A comparison of current route capabilities with those required by the Technical Standards for Interoperability (TSIs)
- A review of route capacity compared to available traffic forecasts
- Scoping of a range of possible rehabilitation and upgrade options
- Broad assessment of costs and timescales for the range of options
- Determination of an overall project strategy

At an early stage, the results of these strategic reviews are fed into the national Sectoral Operational Plans – Transport, to establish their place in the national rail transport strategy and to allocate budgeted funding.

Once the projects are established, the IM will seek funding from ISPA or other sources for technical assistance to carry out a feasibility study. This will be directly remitted by the IM and will look at a given range of options for route refurbishment, with the intention of determining:

- The estimated costs and timescales of the principal options
- Key design factors such as route alignment, track layouts, etc.

- Asset condition and renewal or life extension options
- Bills of Quantities
- Implementation methodologies which minimise disruption to the operational rail network while upgrade works are being undertaken
- Demand forecasting to determine the capacity required on the route for a given option
- Potential financial and economic benefits (including a draft Cost Benefit Analysis)
- A recommendation as to the chosen option which best meets the output objectives and meets identified funding constraints
- Tender documentation

Following this, the IM will apply to funding for projects on a prioritised basis, from central government or an International Financial Institution (IFI), or a combination of the two. The IM will use the outputs of the feasibility study, including crucially the cost estimates, to specify the level of funding required and to generate the economic and financial justification. Up until this point, normal rail projects are totally within the IM's control.

However, the IM normally does not have the technical design capability or construction resources to carry out the design and implementation phases of the project, and this is normally contracted to the market, where a number of international construction firms possess the necessary design certification and technical expertise to carry out such work.

These contracts are normally let on a design and build basis, with the contractor being responsible for both the design and construction methodology, and responsible for any sub-contracting for specialist services within the overall contract mechanism. Given that this phase includes detailed design, including production of construction drawings, detailed asset surveys and focus on a much greater level of detail than was addressed in the feasibility study, it is common for issues to arise that had not previously been foreseen, and for component pricing to vary quite considerably.

It is usual in the design and build contracts for the contractor to adopt most of the project risk for items that were contained within the findings of the Feasibility Study but for the client to retain the risk for areas which had not been previously identified, for example, poor ground conditions or worse than expected asset conditions.

In most cases, the tendering procedure and funding applications operate in parallel, and it is not uncommon in recent schemes observed by the study for contracts to be let in advance of confirmation of IFI funding, and therefore essentially at the IM's risk.

It therefore follows that rail projects have a different development format to road projects. There is more tendency for a mid-project handover between a development contractor and a design and implement contractor, which has the potential to allow an amount of risk generated by the transition to remain with the awarding authority. This may be the cause of project cost overruns observed in some countries.

Country Specific Evidence

BUL: Rail sector activity is dominated by maintenance, which is undertaken by NRIC (National Rail Infrastructure Company) using direct labour, and renewals or rehabilitation, which are carried out either by NRIC or contractors depending on the size and nature of the work. NRIC has limited mechanical track relaying equipment and therefore is unable to undertake all this work itself. There are few major new projects due to lack of funds and difficulties in preparing projects for implementation. Thus the contracting market can be said to be immature with few international contractors. There is a history of projects overrunning and significantly exceeding their estimated costs.

ROM: facets of the rail market (track, signalling and overhead line) are more specialised so that the very nature of the works limits competition for contracts to those firms which already have design certification and relevant railway experience. Evidence suggests that there are only a few firms in Eastern Europe with this level of expertise, and not all are capable of working in every country.

Little competition and very limited interest from international contractors (with bid prices perceived as high) are the main features of the *Latvian* rail supply market.

2.2 Transport Operational Programmes (OPs)

2.2.1 Introduction

The Transport OPs help to give a further element of context to the construction markets in each country. In the current programming period (2007-2013), these are significant in scale and provide the participating countries with opportunities to obtain significant volumes of grant finance to accelerate road, rail and urban public transport development.

Table 2.1: Transport OP (2007-2013) Community Contribution by country (million Euro)

	Road	Rail	Urban Transport	Multimodal transport	Intelligent Transport Systems	Total	% of all 9 countries
Bulgaria	791.67	464.00	0.00	157.41	16.02	1,429.11	4%
Czech Republic	2,570.29	2,583.88	297.07	27.09	121.43	5,599.76	16%
Estonia	247.27	185.31	129.68	0.00	3.20	565.45	2%
Latvia	498.51	257.20	119.60	0.00	0.00	875.31	3%
Lithuania	676.94	566.40	74.39	63.62	0.00	1,381.35	4%
Poland	11,313.95	4,849.69	0.00	108.90	100.00	16,372.54	48%
Romania	2,096.34	1,853.54	0.00	12.81	126.94	4,089.64	12%
Slovakia	1,713.12	1,253.58	89.47	102.62	0.00	3,158.79	9%
Slovenia	390.93	449.67	0.00	3.70	0.00	844.30	2%

2.2.2 The Appraisal Process

The main aspects of the OPs of relevance to this Study are project appraisal and selection procedures and how these may relate to cost estimation and management. The appraisal procedures are based on the key elements set out in Box 1:

Box 1 Key elements of Appraisal Process

Economic Appraisal

Economic appraisal considers costs and benefits and, from the viewpoint of assessing the Economic Net Present Value (ENPV) of a scheme, should give equal weight to the accuracy of the estimates of each. From a project management perspective it is the accuracy of the cost estimates which matters.

The same basic cost estimates are used in the economic and financial appraisals. Market price estimates before the application of CFs are used in financial appraisal. Conversion factors are applied to cost estimates at market prices to derive economic prices.

Base Case cost estimates used in estimates of economic Net Present value (NPV) exclude contingencies[4].

Economic appraisal is conducted at constant prices.

Economic appraisal requires sensitivity tests, which typically include a variation reflecting uncertainty in the estimate of capital costs and risk analyses which incorporate these variations in a probabilistic fashion to establish the likelihood of a negative NPV. Further details are given in the discussion of Quantitative Risk Assessment in section 3.3.

[4] European Commission Directorate General Regional Policy - Guidance on the Methodology for carrying out Cost-Benefit Analysis: Working Document No 4 (August 2006) - page 9

Financial Appraisal and Funding Gap Estimation

Total investment costs (E1.2[5]) input to the FIRR and Funding Gap (FG) estimates also exclude contingencies.

Eligible costs (Table H1) can include contingencies (up to a maximum of 10% of the capital cost excluding contingencies) and price adjustment (PA) to take account of price escalation between the time of the Application and contract award. The EC contribution (H.2.1) is a product of eligible costs and the funding gap rate. Thus, contingencies and PA amount are incorporated in the estimate of the EC contribution.

2.3 Project Cost Development

2.3.1 Introduction

This section summarises the work on cost development (Task 9). The analysis and results on cost benchmarking (Task 7) are presented in section 2.4. These tasks use data from actual projects planned and constructed in the nine participating countries over approximately a ten-year period[6].

2.3.1.1 Objectives

The Terms of Reference specify five sub tasks within this Task as follows:

i. review collected data from the participating countries on the cost development, on recent relevant projects, from first estimate to final completion cost;

ii. identify the main risks (estimating, design, construction and management risks) throughout the project cycle;

iii. identify which risks have proven to be the major causes of cost developments in each country;

iv. advise on a method to quantify the impacts of these risks and make suitable allowances at project and programme level;

v. provide recommendations for improvements of current cohesion fund regulation concerning contingencies (to possibly replace current 10 % allowance for project cost in CF applications).

This report focuses on sub task (i) and sub task (v). Sub tasks (ii) to (iv) are discussed in the report on Task 10: Risk Management.

2.3.2 Scope

2.3.2.1 Sector scope

<u>The Rail Sector</u>

The rail project data base was too weak to enable any conclusions to be drawn on cost development. Rail projects consist typically of large sections of route upgraded as a single unit, and while the project may be split into discrete segments based on technology (track, signalling, overhead line and power supply etc.), the data we were provided with was at project level. In most cases, therefore, there were only two or three projects per country to evaluate and the scope of the projects varied considerably. Drawing useful comparisons between projects for benchmarking purposes was therefore very difficult.

The rail database is small in comparison to road. For some projects cost data was only supplied for one point on the timeline. Where data was supplied for more than one point on the timeline this data did not always appear reliable, with costs being the same throughout the lifecycle in some cases. In others, at earlier stages there are very high values given for "Other costs".

[5] References in this Box refer to sections of the CF/ERDF Application Form.

[6] It was necessary to choose completed projects for which outturn costs were available. However projects "too old" were rejected as it was considered that the appraisal and planning/ procurement and construction management of these did not reflect current practice. Further details are given in the Data Collection Report.

It is understood that in some cases the railway companies will fund any short fall in the project budget themselves out of their maintenance budgets, but this will not be shown in the final outturn project cost as declared to the EU. This will influence any analysis of cost development over the project lifecycle, with such a project appearing to come in on budget when in fact further money was spent.

In some countries, projects are costed using standard rates which have been used for a number of years and which contractors also have access to. This therefore makes it likely that the contractors will cost a project at a very similar value to the railway company, and thus the cost at contract award may not vary much from that at appraisal.

There are also procedural differences between countries. Some countries use grants from the EU only to purchase the materials and carry out the work themselves, whereas other countries use the grant to fund a contractor whilst purchasing their own materials. This therefore affects the development of costs, with less potential for cost overruns when only materials are purchased using grant monies.

The Urban Transport Sector

It was not possible to compile reliable cost development data for urban transport. Any data produced may not be meaningful for the participating countries as the database mainly comprised projects in EU countries outside of the nine participating countries.

The Road Sector

For the reasons described above, the following sections therefore relate only to the road sector.

2.3.2.2 Geographical scope

The geographical scope of the road sector element of Task 9 covers nine countries with the beneficiary organisations as set out in Table 2.2.

Table 2.2: Road and motorway sector beneficiaries

Country	Beneficiary
Estonia	Estonian Road Administration
Latvia	Latvian State Roads
Lithuania	Lithuanian Road Administration
Poland	General Directorate for National roads and Motorways (GDDKiA)
Czech Republic	Road and Motorway Directorate
Slovakia	Slovak Roads Administration (SSC) National Motorway Company (NDS)
Slovenia	DARS
Romania	National Company Motorways and National Roads
Bulgaria	National Road Infrastructure Fund

2.3.2.3 Temporal scope

Projects have been selected for inclusion in the data base on the basis of being "not too old" (reflecting outmoded practices) and yet "not too young" (to recent to yield contract price or outturn cost information. Allowing for an average procurement and build period of 3-5 years, the majority of projects have been appraised in the period 2000-2004.

2.3.3 Methodology

2.3.3.1 Project types

In general terms, the methodology has been to collect historic information on cost development. In contrast to the work on cost benchmarking in Task 7, it has not been necessary to restrict the database to "standard" projects. Thus, whilst the majority of projects have been the three standard types used in the benchmarking: road rehabilitation, new national road, new motorway, it has been possible to include other projects such as those involving a high % of structures in the overall scope of works.

2.3.3.2 Information sources

Cost information has come from two sources: project fiches, provided by the beneficiaries in response to a pro forma supplied by the Consultant and; information on EIB-funded projects, reported in EIB Appraisal reports, EIB Project completion reports and project implementation monitoring reports undertaken by independent consultants for the funding agencies. The composition of the database (as used for Task 9) according to information source is set out in Table 2.3.

Table 2.3: Composition of database by information source

Country	Project Fiches	EIB Reports
Estonia	17	0
Latvia	7	0
Lithuania	10	0
Poland	4	27
Czech Republic	6	0
Slovakia	8	3
Slovenia	4	5
Romania	0	8
Bulgaria	0	10
Total	56	53

The criteria used to screen these data are set out in Box 2.

Box 2 Data Screening Criteria

The project data received were reviewed to ensure the quality of the data. Where necessary, projects were excluded from the database where information was felt to be unreliable due to inconsistencies or gaps in the information received, or where information was too uncertain (for instance where final outturn costs had been provided but the project was still some way from completion).

This process ensured that the projects and cost information included in the database were comparable. The following steps were undertaken in the data verification process:

i) Is there an adequate technical description of the project? This needs to describe the works in sufficient detail that the project can be categorised and the major items which have contributed to the outturn project cost identified ;

ii) Are there cost estimates for at least two points on the project time line?

iii) Is this a "standard" project[7] ?

iv) Is the final outturn cost of the project provided?

v) Confirm the currency units in which costs are expressed – typically these will be local currency or euro;

vi) Confirm the date (month and year) and the price base of the cost estimate provided – for each estimate on the project time line, these may be two different dates for example an estimate may be sourced to a report issued in April 2002, but this same estimate may be expressed in January 2002 prices;

vii) Where cost estimates have been converted from one currency to another, confirm the date (month and year) of the exchange rate which has been used in this conversion;

viii) Confirm that VAT excluded;

ix) Confirm statement on the treatment of contingencies

2.3.3.3 Project timelines

Cost estimates were labelled based on the time of estimate according to eleven points on each project time line as follows:

1. feasibility study
2. funding agency appraisal report
3. decision-to-proceed/commitment from funding agency
4. outline design
5. detailed design/issue of tender documents
6. receipt of bids
7. receipt of all critical permits and approvals
8. signing of contract with winning contractor
9. during construction
10. at the time of project opening for traffic
11. handover of completed works/final financial settlement with contractor

The analysis has focussed on three points, at stages 3, 8 and 11.

Table 2.4: Cost estimate points on time line

Cost estimate	Point on timeline
C1	Point 2 (appraisal) or point 3 (decision to proceed)
C2	Point 8 contract award
C3	Point 10 (opening to traffic) or point 11 (handover of works)

[7] There are 4 types of standard project in the study: motorway 2 lanes in each direction; new national road one lane in each direction; national road rehabilitation; railway line rehabilitation.

As the Study has developed and the difficulty of obtaining reliable data has become more apparent, it has been decided to retain projects in the database even if information is lacking on one of C1, C2 or C3 – that is a project can provide useful information on the relationship between C2 compared to C1 even if the final outturn C3, is not known – or it may provide data on C3 compared to C2 even if we cannot identify the cost estimate at appraisal[8].

2.3.3.4 Projects compared to contracts or lots

In some cases, "projects" as defined at appraisal have been sub-divided into contracts or lots. In these instances cost information relating to stages 8 to 11 has related to these contracts and it has been necessary to sub divide total project costs at stage 3 to produce cost information relating, essentially, to the same scope of works at all of these three stages on the timeline.

2.3.3.5 Reference Class Forecasting

This method employs a Reference Class forecasting (RCF) approach[9]. This is based on the theory that the historic population or reference class of projects can, in some sense, be considered indicative of the future class of projects now envisaged within country operational programmes.

The assessment of "indicative" needs to take account of not only of project scope but also of project preparation and process (appraisal, costing methodology, land acquisition and permitting, environmental procedure, procurement and contract type) – just to name some of the main elements. If a broad level of agreement can be established, RCF can provide a basis to transfer the results from analysis of the historic population of projects (learn from the past) to the preparation of the set of projects in the OP pipeline to 2013.

Establishing the Probability Distribution (RCF- Stage 2)

Establishing the probability distribution for the selected reference class is the second step for the application of RCF. This step, however, should look at the overall cost over/under run of the sample, namely the R3 ratio. Nevertheless, two ratios, namely R1 and R2 have been calculated to partition cost development between appraisal and final outturn. Ratio R1 looks at the cost development between the appraisal stage and the contract award. Ratio R2 measures cost development between the contract award and final outturn.

The probability distributions for all three ratios have been calculated using both current and constant prices. These ratios are presented in section 2.3.4 and 2.3.5.

Estimating the Uplift Percentage (RCF- Stage 3)

The third stage of the RCF looks at comparing the specific project with the reference class distribution, in order to establish the most likely outcome for the specific project. In this study, however, the aim of the stage is to illustrate the level of uplift an investor might need to consider to lower the possibility of cost overrun occurrence.

2.3.3.6 Questions addressed

Cost development is concerned with the extent to which construction cost estimates change from initial estimates through project planning and preparation to final outturn costs.

In this context, two questions were considered:

- was the construction cost estimate accurate? and
- was the loan or grant amount sufficient?

Thus projects eligible for the cost development database did not have to be as "standard" as those used for cost benchmarking where the objective was to compare the costs of the same "standard" project.

8 In the majority (85%) of cases cost information is available for all of C1, C2 and C3
9 For a brief explanation See Flyvbjerg "From Nobel Prize to Project Management: Getting Risks Right." Project Management Journal, vol. 37, no. 3,August 2006, pp. 5-15.

2.3.4 Was the Construction Cost Estimate Accurate?

2.3.4.1 Method

This question focuses on the quality of cost estimates at the time of scheme appraisal. To address this question, the analysis has been conducted at constant prices[10]. We have elected to work at the prices applying in the month and year of the cost estimate used at appraisal (stage 3 on the timeline). Where a cost estimate at appraisal was not available, the month and year of the cost estimate at contract award was used as the price base.

Two deflators were considered: the Consumer Price Index (CPI) and the Road Construction Price Index (RCPI). The development of these indices in the nine countries is illustrated in the tables and graphs in Appendix B. As the objective of the analysis was to identify construction cost inflation over and above general price increases, the CPI was used as a deflator.

Cost development in this study is captured by the ratios shown in Table 2.5.

The cost estimates C1,C2 and C3 input to the analysis to address this question exclude contingencies, price adjustment, VAT (and other taxes) and any allowance for interest during construction. Thus, "base" (without contingency or other add-on) cost estimates at stage 3 are compared to contract award and final outturn costs – all at constant prices[11].

The probability distributions of three ratios, R1, R2 and R3, were calculated at current (for Question B) and constant (for Question A) prices. Ratio R1 looks at the cost development between the appraisal stage and the contract award. Ratio R2 measures cost development between the contract award and final outturn. R3 is the product of R1 and R2 and measures the overall cost development from appraisal to final outturn.

Table 2.5: Cost development ratio definitions

Cost development ratio	Definition	Road projects: number of data points
R1	R1=C2/C1	98
R2	R2=C3/C2	95
R3	R3=C3/C1	102

The results of the analysis should potentially provide answers to Question A with regard to the quality of construction cost estimates in each country and overall. Potentially, the overall cost development ratio R3 can provide an input to the ex post evaluation of scheme appraisal[12].

The results may also be compared with other databases to establish how the quality of road construction cost estimating in the nine countries compares with the evidence from other populations of such estimates from different countries and time periods.

This approach has the implication that cost increases shown are those which occurred in the project or contract in question *over and above* the increase in the CPI (general inflation).

[10] At appraisal, scheme costs and benefits are estimated at constant prices. If, ex post, it is established that scheme costs, measured at constant prices, were an under estimate, the conclusion that can be drawn is that the scheme in question may have been approved when, other things being equal, it should not have been as the outturn Net Present Value or Economic Internal rate of Return has been shown to be lower than that estimated ex ante.

[11] We have considered whether the "base" cost estimate should include any allowance for physical contingency made at appraisal. The logical basis for this would be if decision rules made clear reference to the contingency amount, for example through employing the results of a risk analysis reflecting uncertainty in capital costs and the estimation of a Expected [project Net Present Value] or Expected economic Internal rate of return. EC Guidance does not make this link, so we have no basis to include contingency in cost C1.

[12] That is, if benefits streams could be re-visited ex-post, it would be possible to re-estimate economic internal rates of return and, potentially, assess whether the same list of projects would be approved ex post as were approved in practice.

2.3.4.2 Results: was the construction cost estimate accurate: constant prices

Table 2.6 and Figures 2.1 – 2.6 show a summary of the number of projects that came within budget (not more than 1% over or underrun), over or under budget.

Notably, they show that around 50% of the Class finished with a lower cost than the appraisal estimate. Whilst the costs of the remainder of the projects were underestimated as follows:

- up to 135% cost increase between the appraisal stage and the contract award (R1<= 135%) (Figure 2.2),
- up to 59% cost overrun between the contract award and the completion of construction (R2<= 59%) (Figure 2.4), and
- up to 273% cost escalation between the appraisal stage and the completion (R3<= 273%) (Figure 2.6). However, this result is distorted by one project, excluding this there is up to 126% cost escalation.

Table 2.6: Summary of number of projects over or under-running

	R1	R2	R3
Under budget	50	43	49
Within budget	3	7	4
Over budget	45	45	49

Figure 2.1: Probability distribution of cost increases between appraisal and contract award (R1) - constant prices

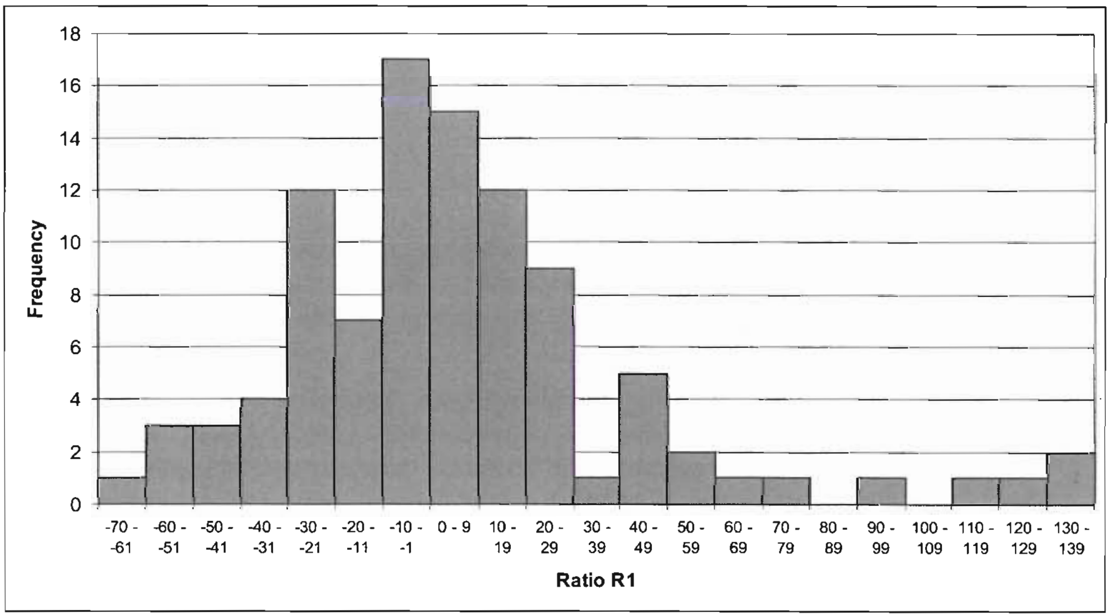


Figure 2.2: Cumulative probability distribution of cost increases between appraisal and contract award (R1) - constant prices

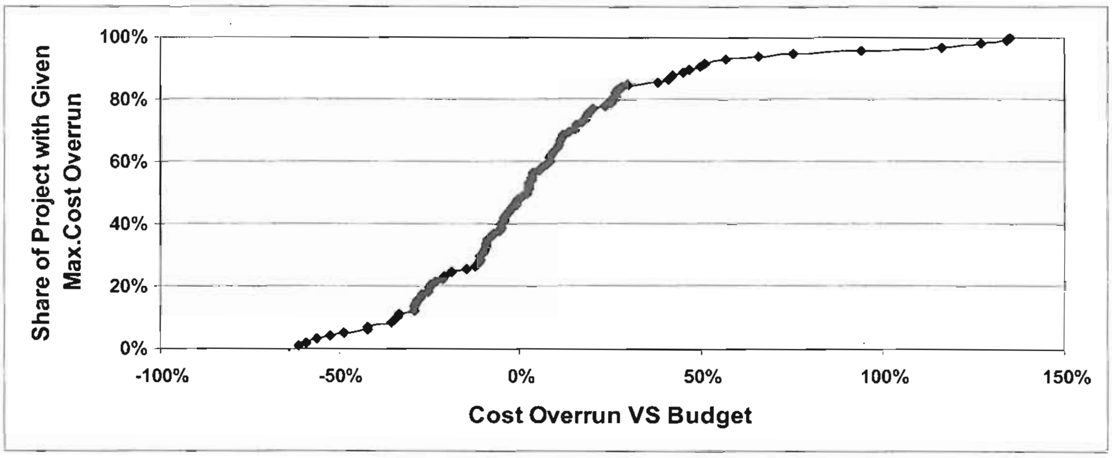


Figure 2.3: Probability distribution of cost increases between contract award and final outturn (R2) - constant prices

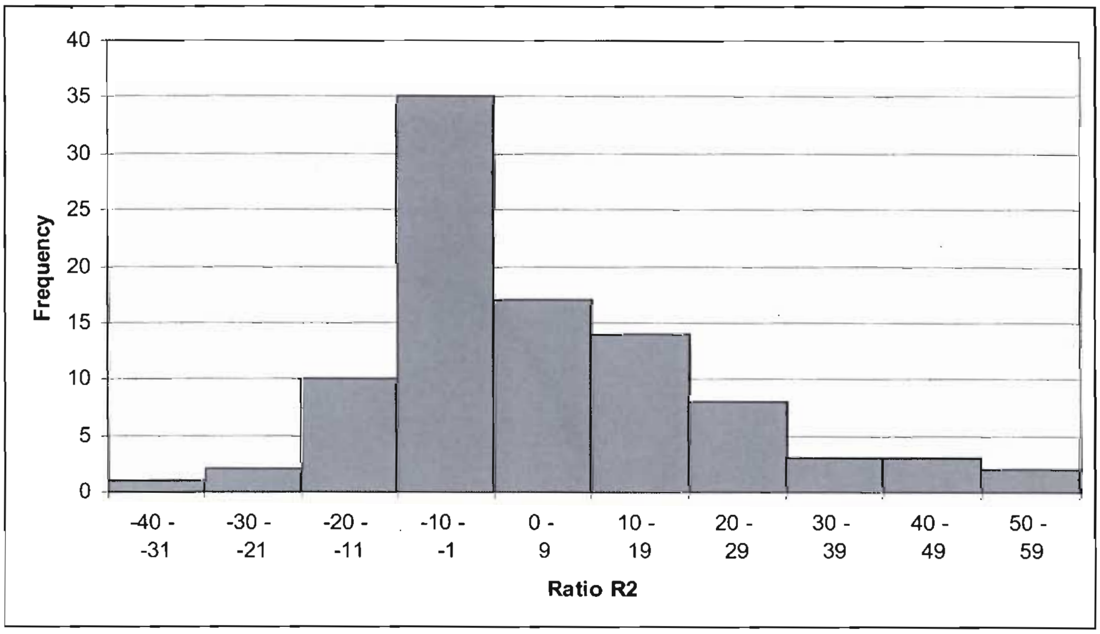


Figure 2.4: Cumulative probability distribution of cost increases between contract award and final outturn (R2) - constant prices

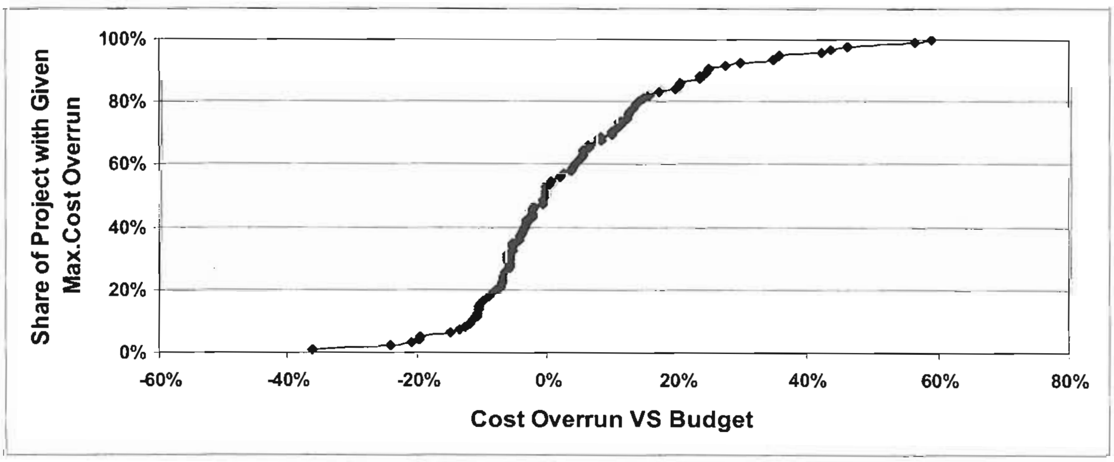


Figure 2.5: Probability distribution of cost increases between appraisal and final outturn (R3) - constant prices

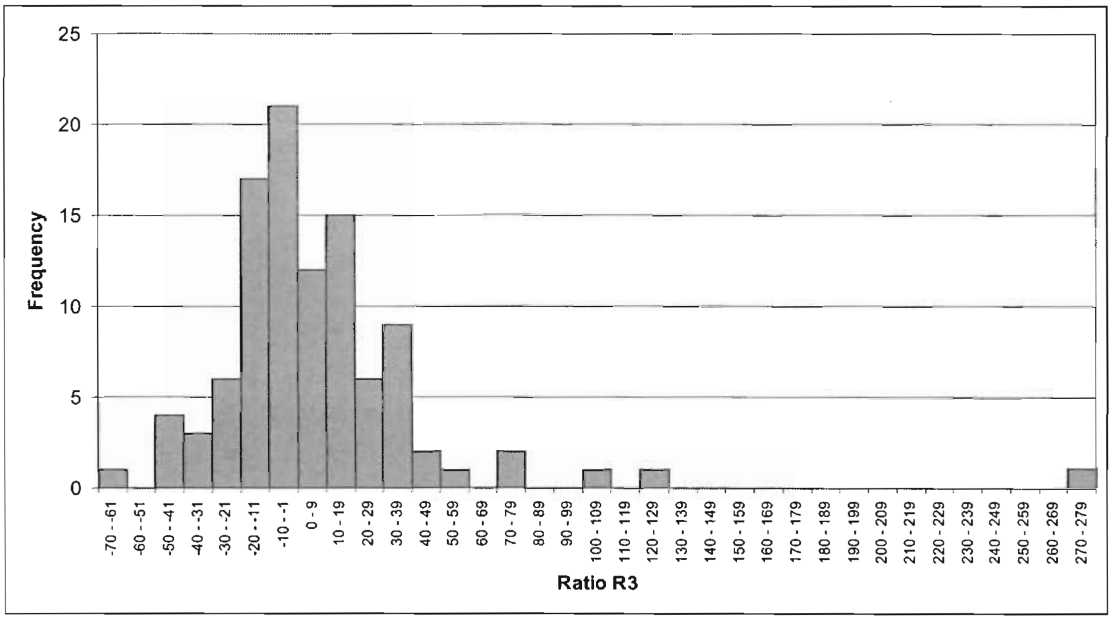


Figure 2.6: Cumulative probability distribution of cost increases between appraisal and final outturn (R3) - constant prices

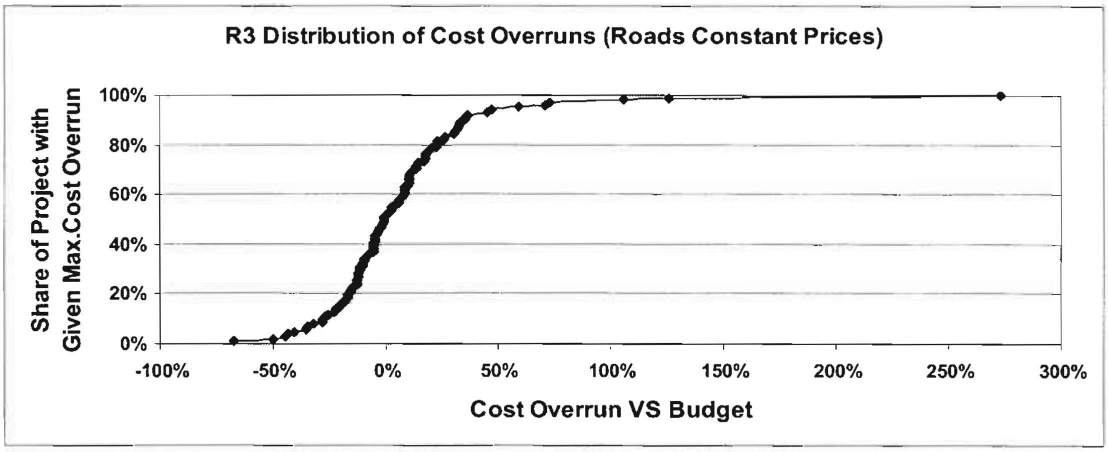


Table 2.7 summarises the statistical outputs for all three ratios. These results show that the *average* cost overrun from appraisal to completion, R3, is only 7%. However, there is a high standard deviation of 39% indicating a high risk of both cost overrun and cost under-run.

Table 2.7: Inaccuracy in cost forecast for road projects- Constant Prices

Ratio (Constant Prices)	*Number of Projects (n)*	*Quartiles (25/50/75%)*	*Average cost escalation (%)*	*Standard Deviation*
R1	98	-17/ 2/ 19%	6%	38%
R2	95	-7/ -1/ 12%	4%	17%
R3	102	-12/ -1/ 18%	7%	39%

2.3.5 Was the loan or grant amount sufficient?

2.3.5.1 Method

To address this question, the analysis has been conducted at current prices. We have elected to use cost estimates based on prices reflecting expenditures in the months and years when these expenditures have been incurred. Final outturn contract costs reflect the sums of contractor invoices over time at the prices current at each invoice date. We have worked in these current prices with no deflation or adjustment.

The cost estimates C1, C2 and C3 input to the analysis to address this question include contingencies and price adjustment. Interest during construction, VAT and other taxes are excluded.

Thus, "base" cost estimates at stage 3 including contingency and price adjustment are compared to contract award and final outturn costs at current prices. The focus of this analysis is the question of loan or grant sufficiency – that is, taking account of the uncertainty in cost estimates, were the physical contingency and price adjustment amounts sufficient?

This approach, we believe, works well in the context of the ERDF/Cohesion Fund Application Form. The key points to note[13] are:

(i) "contingencies should not exceed 10% of total investment cost net of contingencies. These contingencies may be included in the total eligible costs used to calculate the planned contribution of the funds "

(ii) "a price adjustment may be included, where relevant, to cover expected inflation where the eligible cost values are at constant prices"

The results should be directly applicable to consideration of the allowable amounts for contingencies and price adjustment at appraisal. We can review the historic evidence on each of these amounts to see whether the allowances were sufficient or not. We can then comment on whether these should be amended to reduce the risk of the loan or grant amount [or total funds earmarked for the project] being insufficient.

2.3.6 Results: was the loan or grant amount sufficient :roads: current prices

Table 2.8 and Figure 2.7-12 show a summary of the number of projects that came within budget (not more than 1% over or underrun), over or under budget.

These show that:

- For 58% of projects, costs were over estimated at the appraisal stage compared with contract award (R1<= 0%). The remaining projects have cost escalation up to 139%, (R1<= 139%) (Figure 2.8),
- 36% of the projects finished with a lower cost at completion of construction than at contract award (R2<= 0%), whilst the remainder of projects were underestimated by up to 102% (R2<= 102%) (Figure 2.10), and
- For 45% of projects, costs were over estimated at the appraisal stage compared with completion (R3<= 0%), whilst the costs for the remaining project were underestimated by up to 269% (R3<= 269%) (Figure 2.12). However, excluding one project where the escalation was exceptionally high, the project were underestimated by up to 176%.

[13] See Application Form Section H Financing Plan.

Table 2.8: Summary of number of projects over or underrunning

.	R1	R2	R3
Under budget	42	59	54
Within budget	5	18	5
Over budget	52	18	43

Figure 2.7: Probability distribution of cost increases between appraisal and contract award (R1) Current Prices

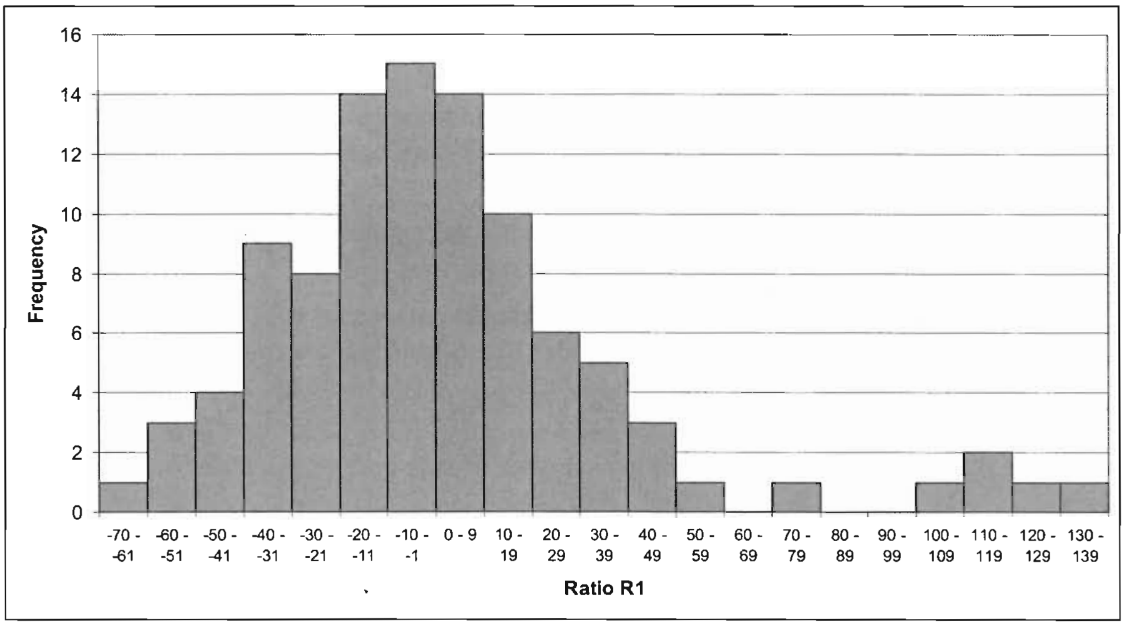


Figure 2.8: Cumulative probability distribution of cost increases between appraisal and contract award (R1) Current Prices

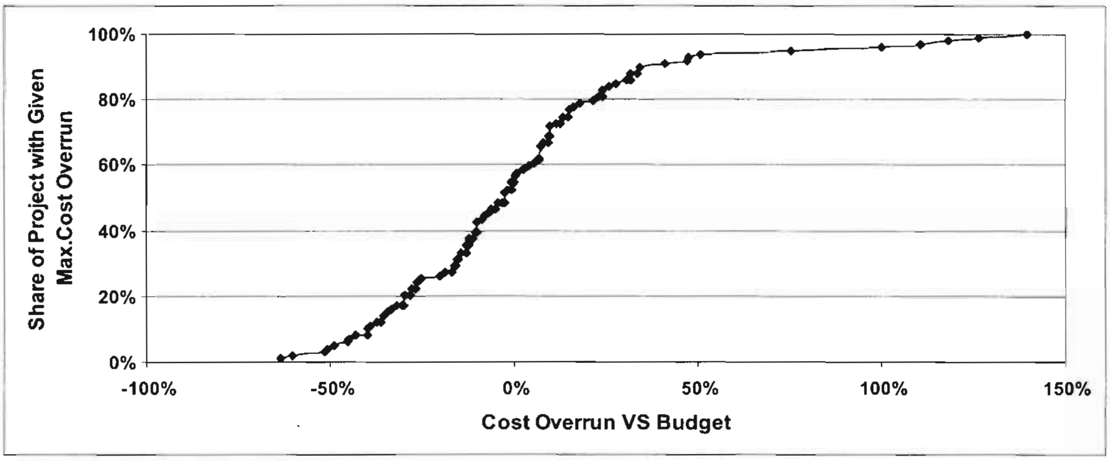


Figure 2.9: Probability distribution of cost increases between contract award and final outturn (R2) - Current Prices

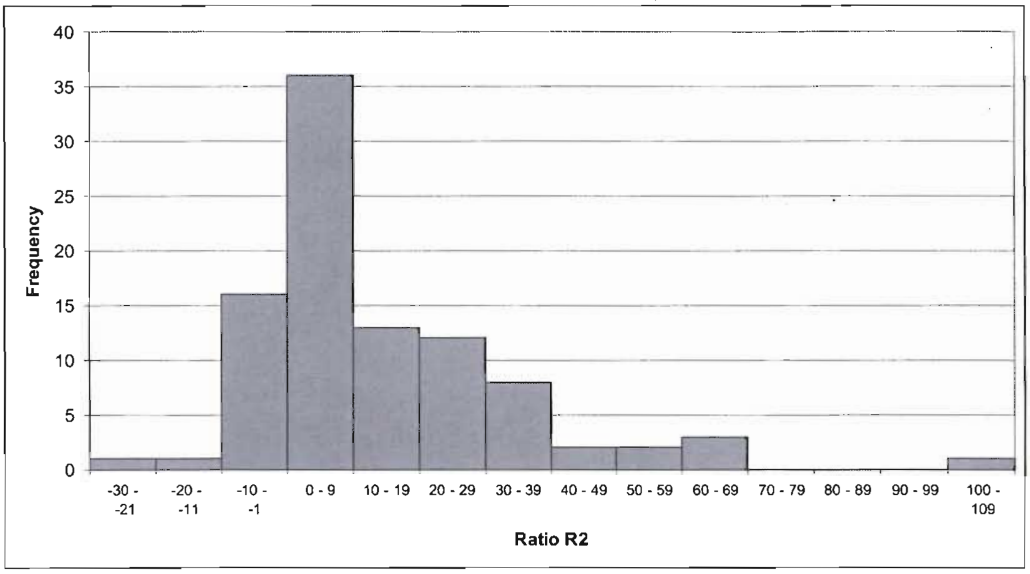


Figure 2.10: Cumulative probability distribution of cost increases between contract award and final outturn (R2) - Current Prices

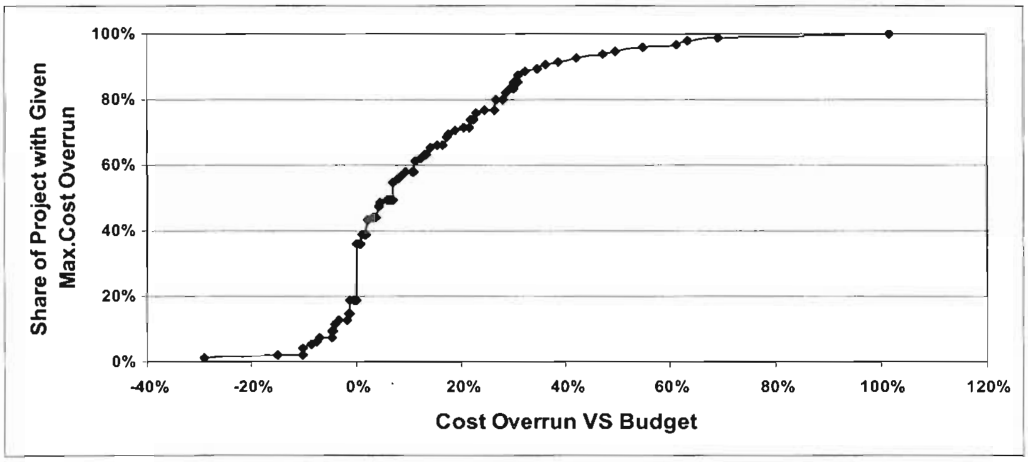


Figure 2.11: Probability distribution of cost increases between appraisal and final outturn (R3) - Current Prices

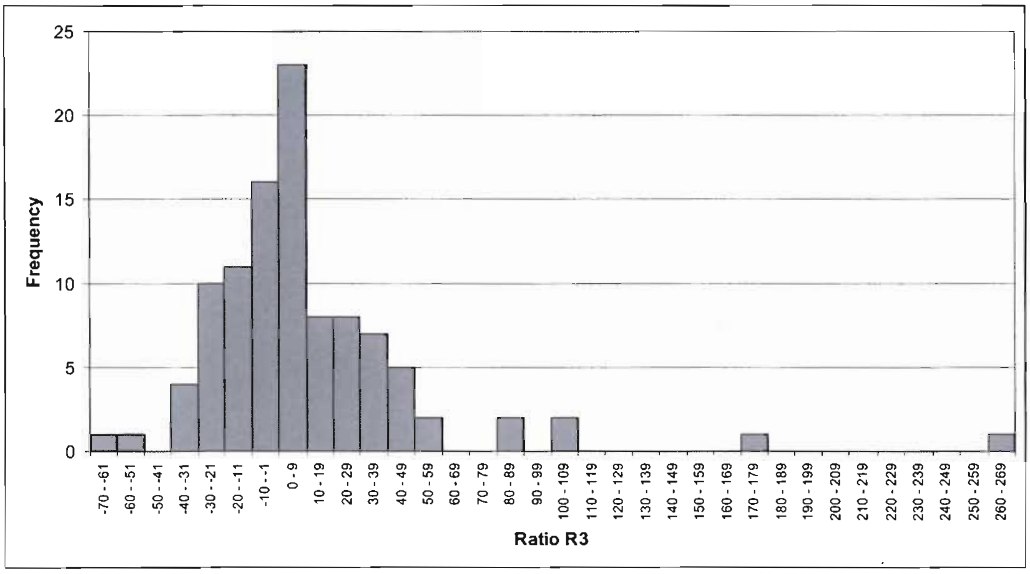


Figure 2.12: Cumulative probability distribution of cost increases between appraisal and final outturn (R3) - Current Prices

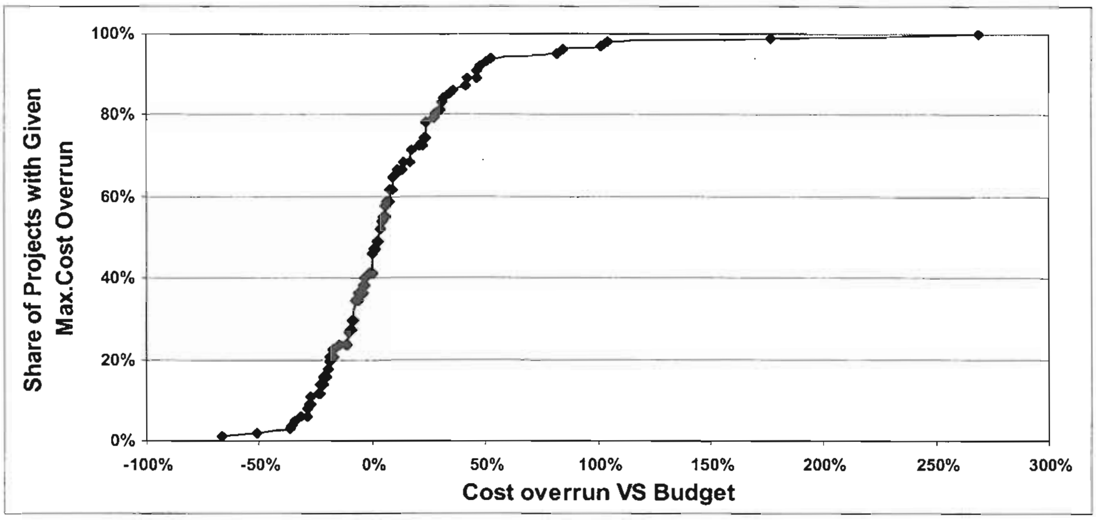


Table 2.9 summarises the statistical outputs for all three ratios at current prices. These results show that the *average* cost overrun from appraisal to completion, R3, is 10%. However there is a high standard deviation of 42%, indicating both overruns and underruns within the dataset.

Table 2.9: Inaccuracy in cost forecast for road projects- Current Prices

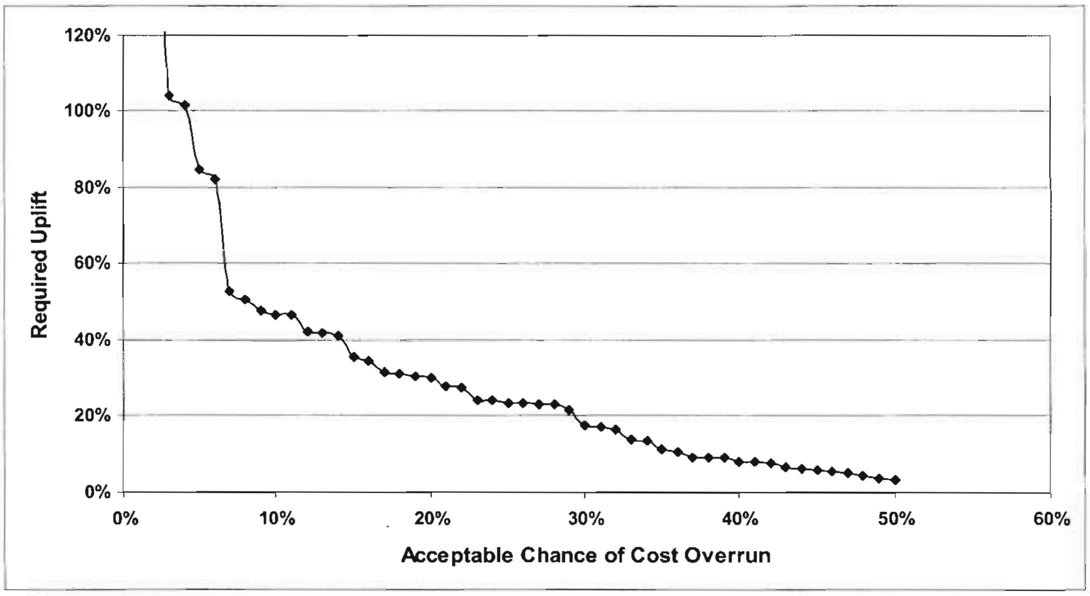
Ratio (Current Prices)	Number of Projects (n)	Quartiles (25/50/75%)	Average cost escalation (%)	Standard Deviation
R1	99	-11/ -3/ 13%	1%	38%
R2	95	0/ 7/ 23%	13%	20%
R3	102	-11/ 3/ 24%	10%	42%

2.3.7 Interpretation: required uplift percentage

Figure 2.13 presents an overview of the applicable uplift percentages using current prices, based on the probability distribution shown in Figure 2.12. Where a high level of certainty is required that costs will not overrun, a higher uplift will be recommended. For instance, with a willingness to accept only 10% risk for cost overrun, the required uplift for the project would be 47%. With a willingness to accept 20% risk for cost overrun, the required uplift for this project would be 30%.

This figure only shows the 50% of projects for which an uplift is required to prevent a cost overrun – of course for the remaining 50% of projects which experienced outturn costs lower than expected , an ex ante uplift would widen the gap between expected and actual outturn cost.

Figure 2.13: Required Uplift for Road Projects as Function of the Maximum Acceptable Level of Risk for Costs Overrun- Current Prices



2.3.8 Conclusions: Road sector cost development

The above results are derived from a database of about 100 road projects planned and constructed over about 10 years across nine countries. These ranged from relatively "standard" road rehabilitation projects to more non-standard grade-separated interchanges.

2.3.8.1 Summary

The following are the main indicative findings from this study:

- In approximately 50% of the database of 102 road projects costs are underestimated in both current and constant prices
- At constant prices, the overall escalation factor, R3, is on average 7% with a noticeably wide standard deviation of 39%
- At current prices, the overall escalation factor, R3, is on average 10% with again a wide standard deviation of 42%
- For the 50% of projects where costs overrun, this overrun is up to 126% in constant prices or 176% in current prices (when one anomalous project is excluded)
- All nine countries had projects with both overruns and underruns
- With a willingness to accept a 20% chance of cost overruns, the required price uplift would be 24% based on the constant price results and 30% based on the current price results. With a willingness to accept a 10% chance of cost overruns the uplift rises to 36% based on constant prices and 47% based on current prices.

2.3.8.2 Conclusions on the accuracy of construction cost estimates.

This analysis compared costs at contract award and final outturn with estimates at appraisal, all at constant prices using local CPI as deflator and appraisal cost excluding contingencies. Average cost overrun (ratio R3) between appraisal and final outturn was 7% but this average disguised a very wide variation in individual contract overruns measured by a standard deviation of 39%. Measured on ratio R3, overrun and underrun were equally as likely to occur. Based on these results, our conclusions are:

1. The maximum allowable 10% contingency is sufficient to cover the estimated 7% overrun *on average*;

2. However, there is a very wide variation in R3, suggesting high probability of underrrun and overrun in excess of 10%. This suggests that it would be useful to consider the possibility of allowing for a higher contingency % in the case of more complex projects or those less advanced in terms of design. This conclusion is developed in our comments on good risk management practice (see section 3.3).
3. Generally there is a strong case for more effort to be devoted to cost estimation practice to improve the quality of cost estimates;
4. These conclusions would be more robust if there were a more extensive database with several hundred projects. The tracking of project cost development should be mandatory. The method and database developed in this Study should be adopted as providing a useful starting point.

2.3.8.3 Conclusion on the sufficiency of funds allocated

This analysis included any contingencies and price adjustment amounts in the base cost (C1) and considered how this compared to the costs at contract award (C2) and final outturn (C3) both measured at current prices. The overall cost escalation averaged 10% suggesting that, on average, taking account of the quality of the original cost estimates, the amounts included for contingencies and price adjustment were insufficient. Again on average, there was a marked difference between the overrun between final outturn and contract award (13%) and contract award and appraisal (1%), suggesting that improved contract management could be the key to reducing cost overruns where these occur. Again there was evidence of very high variability (standard deviation of 42%) in these results between individual contracts[14]. The conclusions from these results are:

1. Since contingency is capped at 10% there is a case for encouraging countries to include an allowance for price adjustment amounts. The scale (%) cannot be said as this would depend on current and future inflation rather than information from this historic database. This would be especially the case if the contract includes a price adjustment clause increasing the possibility that the risk of cost escalation would be shared between the beneficiary and/or managing authority rather than being borne solely by the contractor.
2. The remarks above on the need to improve the quality of cost estimates and to manage risks again apply. The wide variation in results suggests that more attention should be given to cost estimation at the early stages, at feasibility study and before outline design, and there should be agreed procedures for refining cost estimates as design develops.
3. The analysis above concludes by showing the required percentage uplift required to cap the risk of cost overrun to a given %. Whilst an interesting overview commentary on the historic and cross-country database, this is more an illustration of an approach that can be applied at individual project level than as information which can be taken literally suggest generic levels of mark-up. As noted, these data relate to projects across countries and time and ignore the 50% of projects which underrun in terms of cost. Improvements in practice over the past, approximately eight years, would also have to be considered before drawing lessons from these historic data.
4. Generally each country does not have a large portfolio of projects. This makes it harder to draw conclusions from analysis of the data, such as % uplifts, which can be applied to individual projects.
5. The beneficiaries are typically responsible for cost estimates and project management – so the current practice by which they are responsible for risk management is broadly appropriate. The procedure required by the ERDF/CF

[14] The standard deviation in ratio R2 (final outturn to contract cost) was somewhat lower at 20% suggesting more consistent evidence of overrun after signing of construction contracts

Application Form by which uncertainties in cost estimates are linked to expected project NPVs is correct. There is however, no formal link between this analysis and the admissible contingency amount (maximum 10%) allowed in the Application Form. This is point is discussed further in section 3.3.6 below.

2.4 Benchmarking of Outturn Costs

2.4.1 Introduction

In this benchmarking exercise, performance is measured in terms of average outturn cost/km. Benchmarking was carried out for the road, rail and urban transport sectors.

2.4.1.1 Objectives

The Terms of Reference specify six sub tasks within this Task as follows:

i. calculate average unit cost for total investment cost and component cost, controlling for five initial cost determinants, by country;

ii. calculate average unit cost for main cost items and perform time series analysis, by country;

iii. compare unit construction cost in different countries and analyse reasons for discrepancies (as a consequence of initial cost determinants and cost determinants that change over time);

iv. list potential corrective measures to be discussed with the clients;

v. propose a range of unit costs to be used for cost estimating purposes during the 2007 – 2013 programming period;

vi. apply the calculated unit costs on the projects included in the OP and provide comments for possible major discrepancies between project's cost estimation in OP and project cost estimation based on applied unit values.

2.4.1.2 Purpose of Benchmarking

Benchmarking is a managerial tool to compare business processes and/or performance. It can be used to help to understand how a business is performing compared to others or compared to a certain standard, allowing the manager to consider what others are doing better and how their performance could be improved.

In this Task, performance is being measured in terms of average outturn cost of road infrastructure projects. Possible improvement measures include improving planning procedures (including verification of project scope), dealing with cost inflation (at a project and programme/budget level) and managing risks. These improvement measures are considered in Tasks 4, 5, 6, 8, 10 and 11.

It should be noted that this benchmarking exercise is not intended to be used for every project proposal to assess whether the cost is sufficiently acceptable. Projects vary too widely for this to be possible. Rather, it is intended to improvement management of investment programmes in JASPERS beneficiary countries.

2.4.2 Scope

Task 7 has required information on final outturn costs. The selection of projects has been driven largely by the availability of data.

2.4.2.1 Road Sector

The geographical scope of the road sector element of Task 7 covers nine countries with the beneficiary organisations as set out in Table 2.10.

Table 2.10: Road and motorway sector beneficiaries

Country	Beneficiary
Estonia	Estonian Road Administration
Latvia	Latvian State Roads
Lithuania	Lithuanian Road Administration
Poland	General Directorate for National roads and Motorways (GDDKiA)
Czech Republic	Road and Motorway Directorate
Slovakia	Slovak Roads Administration (SSC) National Motorway Company (NDS)
Slovenia	DARS
Romania	National Company Motorways and National Roads
Bulgaria	National Road Infrastructure Fund

The majority of projects were completed in the period 2003 to 2008.

2.4.2.2 Rail Sector

The geographical scope of the rail sector element of Task 7 covers seven countries with the beneficiary organisations as set out in Table 2.11

Table 2.11: Rail sector beneficiaries

Country	Beneficiary
Latvia	Latvian Railways (LD)
Lithuania	Lithuanian Railways (LG)
Poland	Polish State Railways (PKP)
Czech Republic	Czech Railways (CD)
Slovakia	Slovak Railways (ZSSK)
Romania	Romanian Railways (CFR)
Bulgaria	Bulgarian State Railways (BDZ)

The majority of projects were completed in the period 2006 to 2009.

2.4.2.3 Urban Transport Sector

Urban transport has been defined as projects of the following types:

- New metro
- New light rail
- New guided busway
- Tram track rehabilitation

This definition takes account of country and municipal aspirations as reflected in the Operational Programmes.

Very few new metro or tram systems have been procured in the nine countries participating in the study. Using only projects in the participating countries would not provide sufficient "standard" projects which would yield useful cost data for benchmarking as required for Task 7.

In order to develop a meaningful database in respect of urban transport projects, it has therefore been necessary to look beyond the nine participating countries and include projects from other European countries.

The countries included in the urban transport element of Task 7 and the number of projects in the database for each country is shown in Table 2.12.

Table 2.12: Urban Transport countries

Country	Number of projects
France	9
UK	5
Poland	2
Turkey	1
Ireland	1
Romania	2
Italy	2
Greece	1
Czech Republic	1
Total	**24**

The majority of projects were completed in the period 2000 to 2009.

2.4.3 Method

2.4.3.1 Data verification and project types

In general terms, the methodology has been to collect historic information on final outturn costs. To ensure like-with-like comparison, the projects included have been restricted to "standard" projects.

In addition, the data received was reviewed to ensure the quality of the data. In some cases the final outturn costs were too uncertain due to the project still being some way from completion, and in some cases the information was felt to be unreliable due to inconsistencies or gaps in the information received. These projects were excluded from the analysis.

Road

Standard projects were classified as ones which did not include a high percentage of structures or involve construction on difficult terrain.

The assessment of whether the project was "standard" was made based on the technical description given of the project. In consequence, a number of projects which could be included in the data base for task 9 (Cost development) were considered unsuitable for cost benchmarking.

The database for road comprised a total of 76 projects.

Projects were broken down into three types:

- New National road – one lane in each direction

- New Motorway or dual carriageway – two lanes in each direction
- National road rehabilitation
  - Light rehabilitation – purely overlay of existing road
  - Medium rehabilitation – overlay of road with further works
  - Full reconstruction – carriageway rebuilt

The total number of projects in the database for each project type is shown in Table 2.13 below.

Table 2.13: Composition of database by project type

Country	New National road	New Motorway / dual carriageway	National road rehabilitation	Total
Estonia	0	0	16	16
Latvia	1	0	5	6
Lithuania	2	0	0	2
Poland	14	6	1	21
Czech Republic	0	4	0	4
Slovakia	2	3	1	6
Slovenia	0	6	0	6
Romania	0	0	8	8
Bulgaria	0	2	5	7
TOTAL	**19**	**21**	**36**	**76**

<u>Rail</u>

Standard projects were classified as ones which include route upgrade or permanent way or signal elements. The database for rail comprised a total of 19 projects. A further 8 projects were excluded as they were more specific schemes, including items such as Hot Axle Box Detectors, new reception yards and station upgrades. It was not possible to draw comparisons between these schemes.

However, even in the projects included, there is insufficient detail in the information provided to be completely confident in the comparability of all of the schemes. Individual schemes vary in scope, for instance some include an element of route diversion to provide for a higher speed capacity.

Projects were broken down into three types in the analysis:

- Route upgrade
- Permanent way
- Signalling

These project types are not mutually exclusive with some projects being included in all three categories where suitable cost breakdowns were available.

The total number of projects in the database for each project type is shown in Table 2.14 below.

Table 2.14: Composition of database by project type

Country	Route upgrade	Permanent way	Signalling
Latvia	0	1	2
Lithuania	0	2	0
Poland	3	3	3
Czech Republic	6	6	5
Slovakia	2	2	2
Romania	3	3	3
Bulgaria	1	0	1
TOTAL	**15**	**17**	**16**

Urban Transport

Some projects were excluded, for instance where they involved particularly difficult construction, where the line ran partly through countryside and where a mixture of underground and surface construction was used.

The database for urban transport comprised a total of 24 projects across Europe.

Project costs were broken down into two categories in the analysis:

- Infrastructure cost
- Vehicle unit cost

Most projects were included in both categories, with the cost of rolling stock being split out from the total project cost to calculate the cost of infrastructure. The exceptions to this are two projects where no costs for vehicles were included and two where rolling stock costs were not included in the information available.

The projects in the urban transport database comprise three distinct groups of technology. These categories are:

- Metro – underground systems with rolling stock conforming to heavy rail principles, with totally dedicated rights of way and specific infrastructure. It can be expected that the civil engineering costs of these systems are high, and rolling stock is also more expensive.
- LRT – surface based light rail systems with routes following existing streets (either with segregated or joint running) and using the same surface levels. Rolling stock is of lightweight construction equating more to bus or coach construction than classic rail vehicles. The track costs can be expected to be lower than for Metro as less work is required to establish the right of way, while rolling stock is of lightweight though very sophisticated construction. Some of these systems use rubber tyres but conform to LRT principles.
- Guided busway – 3 of the projects in the database have adopted a guided busway using French technology. A centre rail is provided for steerage, and the vehicles run on rubber tyres.

The three system types have been shown separately in the analysis.

In addition, there are several projects which involve the rehabilitation of existing tram lines rather than new construction as for the three technology types described above. These are shown separately.

2.4.3.2 Information Sources

For road and rail, cost information has come from two sources: project fiches, provided by the beneficiaries in response to a pro forma supplied by the Consultant and information on EIB-funded projects, reported in EIB Appraisal reports, EIB Project completion reports and project implementation monitoring reports undertaken by independent consultants for the funding agencies.

The effort made to provide "project fiche" data varied considerably between countries. In a number of cases, despite numerous attempts, it was not possible to obtain clear information relating project scope to outturn costs.

For urban transport, the project information has not been sourced from fiches. Instead most project information has been sourced from EIB reports. These were Project Completion Reports where they were available. However, in some cases only Appraisal reports were available and where necessary the information from these has been used. Some caution should therefore be taken with the results as they do not all represent final costs. Some project information has also been sourced from a report by the UK's National Audit Office.[15]

Table 2.15 shows the number of projects for which final costs were available.

Table 2.15: Projects with final outturn costs available

	Number of projects
Projects with final or near final outturn costs	12
Projects with costs only at appraisal	12
Total	24

2.4.3.3 Project timelines

For this task, the cost used is the final outturn cost, that is, the cost at the handover of completed works/final financial settlement with contractor. Where, in some cases for road and rail, the final costs have not quite been finalised, the cost used is that at the time of project opening for traffic. For urban transport, where, in half of cases, only costs at appraisal were available this cost has been used.

2.4.3.4 Definition of costs

For this task, the cost used is the final outturn cost, that is, the cost at the handover of completed works/final financial settlement with contractor. VAT has been excluded from the final outturn cost. The cost used is based on the total cost including land, supervision and design.

2.4.3.5 Projects compared to contracts or lots

The data points in the analysis relate to contracts or lots where a larger section of road was split into smaller distances for procurement[16]. Typically, projects are appraised before consideration is given as to how they may be divided into lots for procurement purposes. This subject is discussed further under cost estimation (task 8) and cost development (task 9).

[15] Improving public transport in England through light rail. National Audit Office, 2004.
[16] Where projects included separate contracts for different aspects of the project such as road construction, bridge construction etc, these were not treated as separate datapoints.

2.4.3.6 Reference Class forecasting (RCF)

This study employs a Reference Class forecasting (RCF) approach[17]. This is based on the theory that the historic population or reference class of projects can, be considered indicative of the future class of projects now envisaged within country operational programme (OP, transport).

The assessment of "indicative" needs to take account of not only of project scope but also of project preparation and process (appraisal, costing methodology, land acquisition and permitting, environmental procedure, procurement and contract type) – just to name some of the main elements. If a broad level of agreement can be established, RCF can provide a basis to transfer the results from analysis of the historic population of projects (learn from the past) to the preparation of the set of projects in the OP pipeline to 2013.

2.4.3.7 Price Base

The analysis has been conducted at constant prices in order to be able to compare costs between projects constructed over different periods. A price base of 2008 has been chosen in order to produce values for a recent year. The Consumer Price Index has been used as the inflator to adjust costs to this 2008 price base[18].

2.4.3.8 Calculation of cost per km

The costs supplied were either in local currency or Euro depending on the country and project. Where the costs were in a local currency, these were converted into Euro based on the exchange rate on the date at the midpoint of the construction period. The price base of the outturn cost was taken to be the year of the midpoint of construction and the costs were inflated to 2008 prices using IMF data for average consumer price inflation by country.

For road, the total cost of the scheme was then divided by the length of the scheme in km to give a cost per km in million Euro.

For rail, the total cost of the scheme was then divided by the route length in km to give a cost per route km in million Euro for the route upgrade and signalling costs, and by the length in single track km to give a cost per single track km in million Euro for the permanent way costs.

For urban transport, the total cost of the scheme was then divided by the route length in km (all of the routes are twin track) to give a cost per route km in million Euro for the infrastructure costs, and by the number of vehicle metres (length of vehicle (m) x no of vehicles purchased) in million Euro for the vehicle costs.

2.4.3.9 Sample size - road sector

Information on all projects carried out over the same period as projects included in the database was sought from the beneficiaries' websites and annual reports.

This was used to make an estimation of the sample size for the countries where there was sufficient information on projects carried out.

For Slovenia there was a comprehensive list of their built motorways and expressways with the dates of beginning and completion. 9 projects were included in the CFPM database, completed over the period December 2003 – August 2008. The total number of projects completed in the same period in Slovenia was 30, therefore a sample size of 30% was achieved.

Information was available for Slovakia on completed motorway and expressway projects. Of the Slovakian projects in the CFPM database, 7 were motorway and expressway projects (there were a further 4 projects in the database, but these were national road projects). These were completed over the period 2005-2010. A total of 34 motorway and expressway projects took place in Slovakia over the same period, therefore the sample size is 21%.

[17] For a brief explanation See Flyvbjerg "From Nobel Prize to Project Management: Getting Risks Right." *Project Management Journal*, vol. 37, no. 3,August 2006, pp. 5-15.

[18] The use of national road construction price indices was rejected as the objective of the analysis was to report, based on the projects in the database, how road construction outturn costs had moved relative to prices in general.

Information from the Latvian Roads Yearbooks indicated that 13 projects were completed over the period 2004-2008. This compares with 7 projects over this period in the CFPM database, therefore a sample size of 54%.

The CFPM database contains 6 projects for Lithuania (some of these were split into 2 or 3 contracts, therefore 10 contracts were included in the database). The LRA's website indicates 11 projects carried out over the same period of 2003-2010. The sample size is therefore 55%.

For Poland, 29 projects were included in the database (some of these were split into more than one contract). These projects were completed over the period 2004-2009. It was only possible to obtain information from the GDDKiA website for motorway and expressway projects, not for national road projects. This indicated that around 44 motorway and expressway projects were completed in total in the same period, compared with 14 of these projects in the database. The sample size is therefore estimated at 32%.

8 Romanian projects were included in the database, which were all rehabilitation projects completed in 2003-2004. These represent all of the rehabilitation projects completed in this period as activity at the time was much lower.

The database included 12 projects for Bulgaria. These were completed over the period 2006-2009. These represent almost all of the major projects completed in Bulgaria over this period, with a sample size estimated to be around 80%.

6 Czech projects were included in the database, completed over the period 2007-2009. These were all motorway projects. Over the same period in the Czech Republic, 16 motorway, 13 expressway and 33 1st class road projects were completed. A sample size of 38% of motorway projects and 10% of all projects was therefore achieved.

It was not possible to obtain any information on sample size for Estonia.

It should be noted that it is not possible to assess whether the projects which were not included in our database were "standard" projects which could have been included in the cost benchmarking analysis . This would therefore affect the sample sizes stated above.

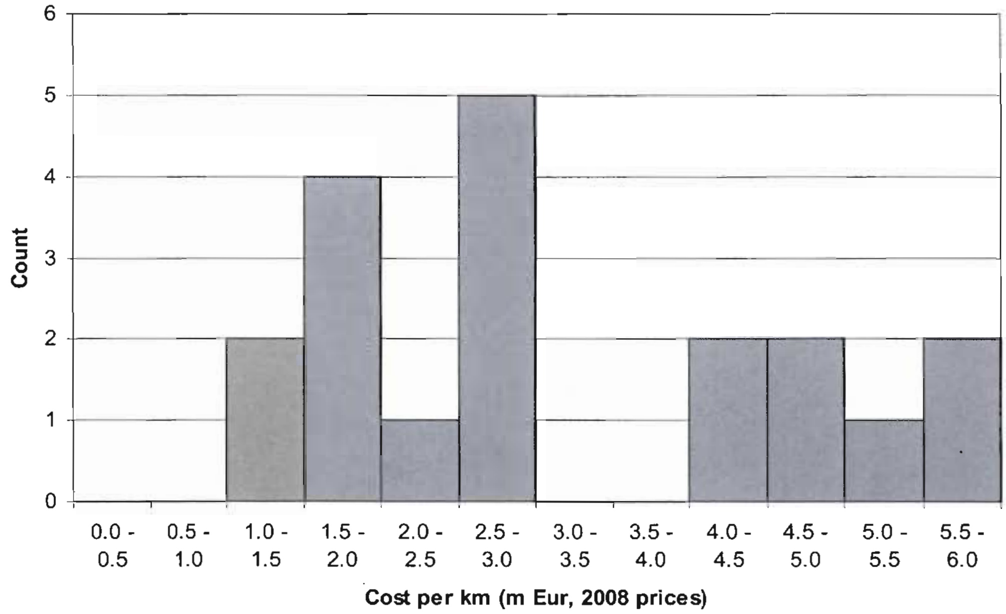
When considering the sample size, it should be noted that the project was limited to standard scope projects and that JASPERS was not in a position to request data for randomly selected projects, but was limited to projects for which the countries supplied the data. This may have resulted in some bias, but any systematic errors occurring in the countries should have been reflected in the sample received as well as in the projects which were not included.

2.4.4 Results: Roads

2.4.4.1 New National Road

The unit costs for new National roads are shown in Figure 2.14.

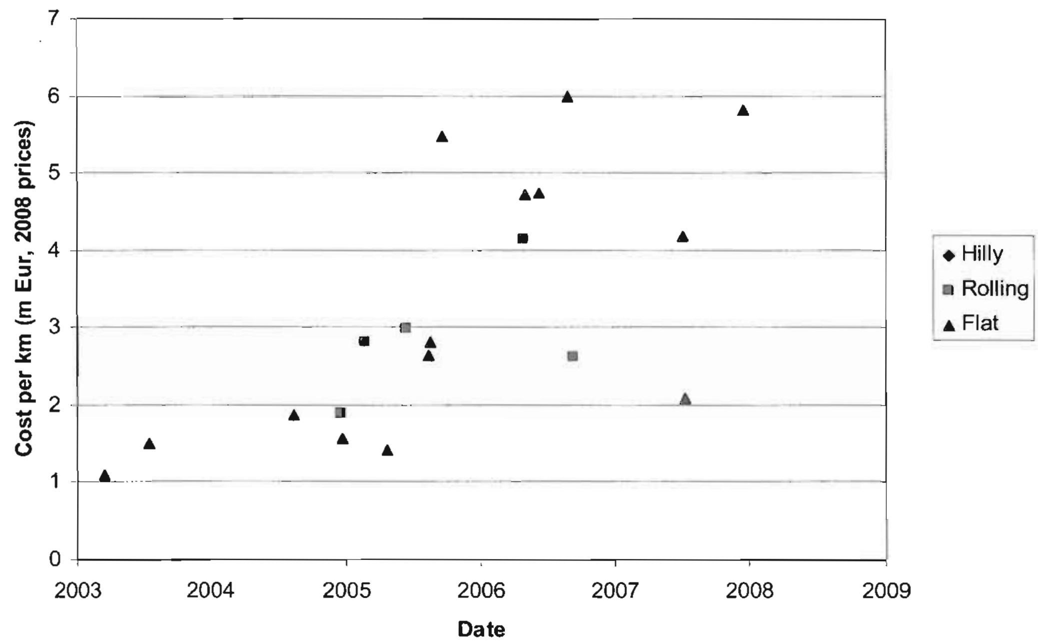
Figure 2.14: Unit costs: new National roads (mil Eur/km, 2008 prices)



Projects ranged in cost from 1.1 to 6.0 million Euro per km.

To establish any underlying variables influencing the unit costs of new national road projects, the projects were also analysed by type of terrain, length of the scheme and length of structure per kilometre of road constructed. These results are shown in figures 2.15 – 2.17.

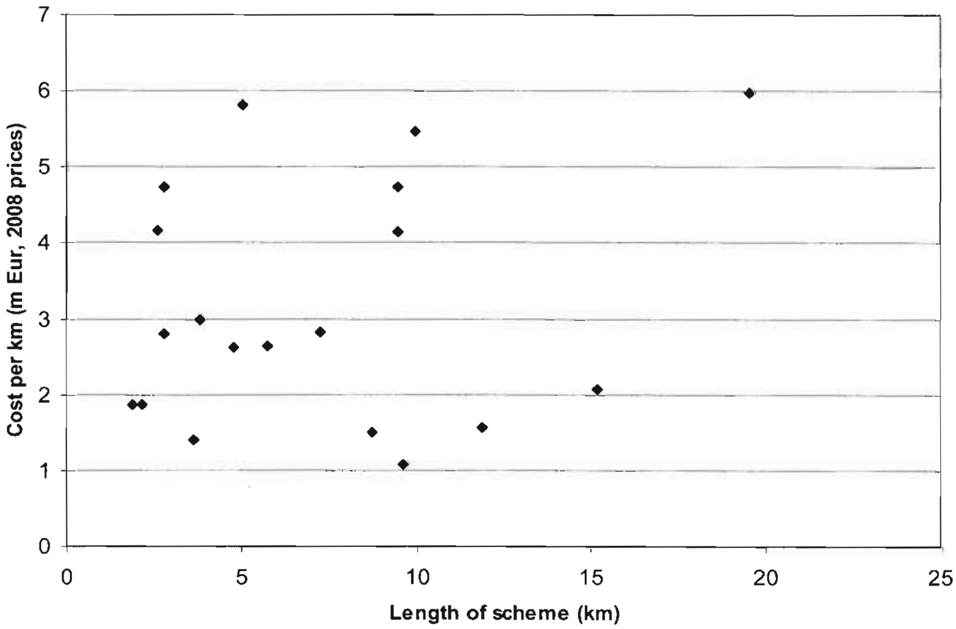
Figure 2.15: Unit costs for new National roads by type of terrain (mil Eur/km, 2008 prices)



There was a tendency for the unit cost to increase over time. In 2003 the average unit cost was 1.3 mil Eur/km compared with 4.0 mil Eur/km in 2007. This represents an average increase in the unit cost, above the level of general inflation, of 78% per annum.

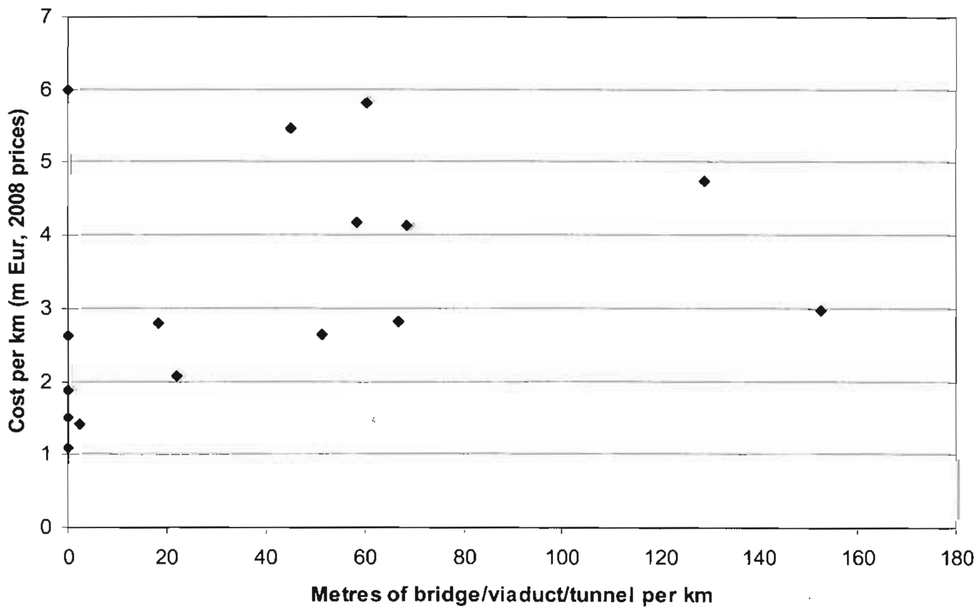
All of the projects included were on flat or rolling terrain. Whilst the projects with the lowest unit costs were on flat terrain, the most expensive projects were also constructed on flat terrain, with those on rolling terrain falling in the middle of the range observed. This suggests that whilst the terrain may explain the higher costs for some projects, there are also other factors which cause some of the schemes on flat terrain to have higher unit costs.

Figure 2.16: Unit costs for new National roads by length of scheme (mil Eur/km, 2008 prices)



It would be expected that as the length of the scheme increased, so the unit cost decreased due to economies of scale in construction works. However, there is no clear trend in the data, with the most expensive project also being the longest.

Figure 2.17: Unit costs for new National roads by length of structures per km (mil Eur/km, 2008 prices)



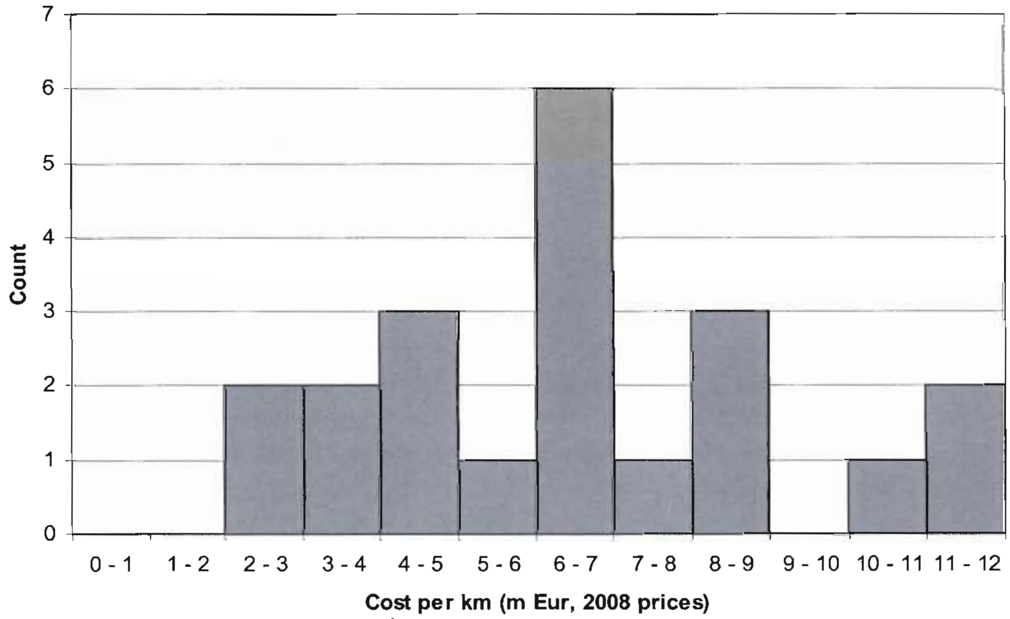
When the data is analysed by the length of structures per kilometre of road, it would be expected that the greater the amount of structures relative to the length of the scheme as a whole, the more expensive the project. However, again there is not a clear pattern, with the most expensive projects not being the ones with the greatest proportion of structures. However, the projects with the cheapest unit costs were the ones with little or no structures. (This figure excludes projects where information on the length of structures was not available).

The unit costs for new National Roads show a wide range with a tendency for the unit cost to increase over time above the level of general inflation. This range of costs is not easily explained by the type of terrain, total length of scheme or length of structures.

2.4.4.2 New Motorway

The unit costs for new motorways or dual carriageways are shown in Figure 2.18.

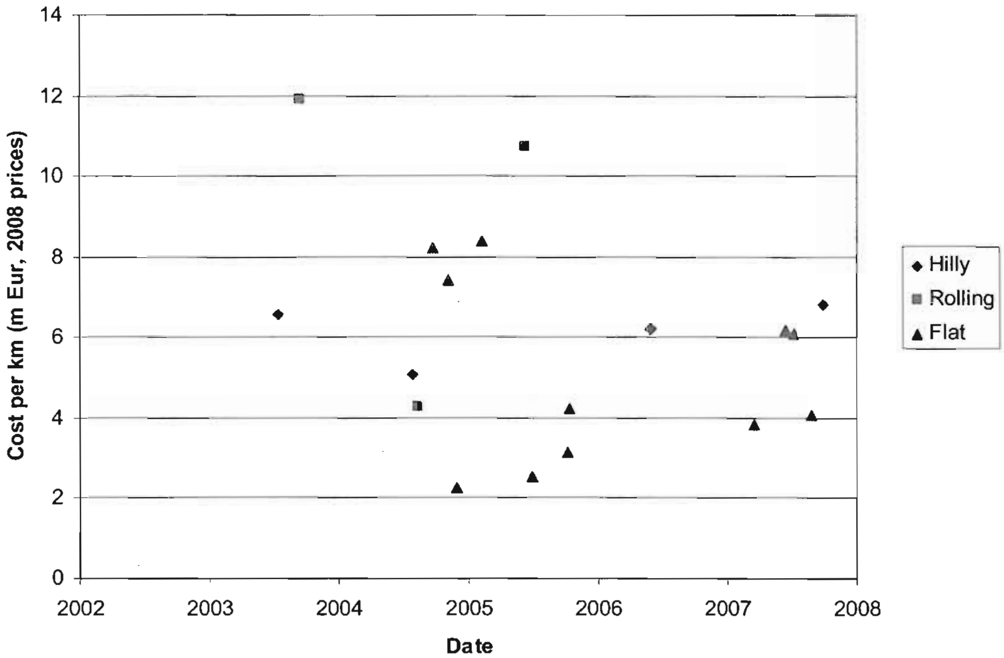
Figure 2.18: Distribution of unit costs for new motorways or dual carriageways (mil Eur/km, 2008 prices)



Projects ranged in cost from 2.3 to 11.9 million Euro per km.

In order to establish any underlying variables influencing the unit costs of new motorway projects, the projects were also analysed by type of terrain, length of the scheme and length of structure per kilometre of road constructed. These are shown in figures 2.19 – 2.21.

Figure 2.19: Unit costs for new motorways or dual carriageways by type of terrain (mil Eur/km, 2008 prices)

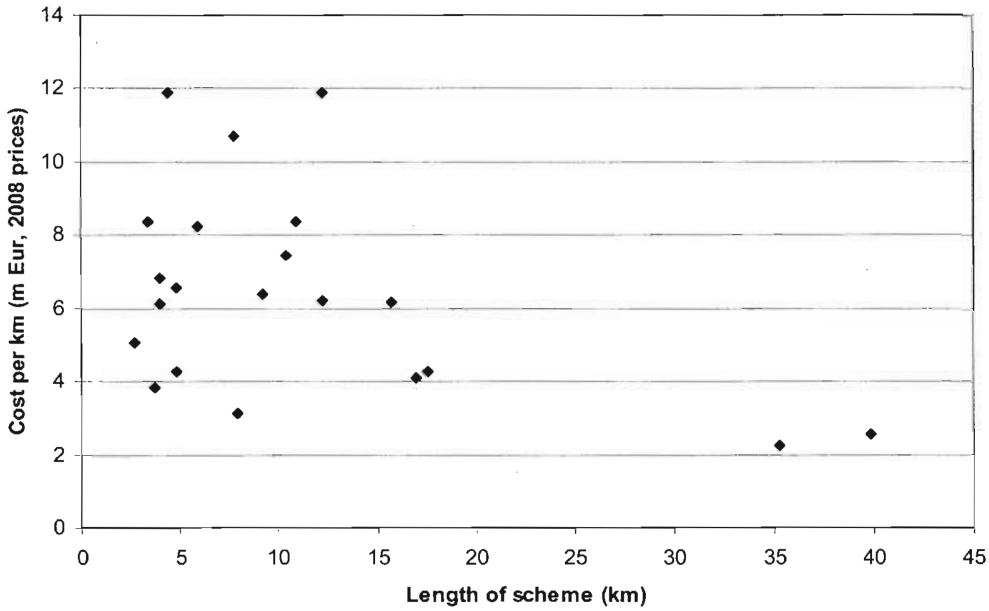


The unit costs did not show any particular pattern over time, with costs within the same country generally showing a relatively narrow range, but different to that for other countries.

As for the new national roads, the results by type of terrain for new motorways do not show the pattern that would be expected. Whilst the cheapest unit costs are for projects on flat terrain, several projects on rolling or hilly terrain are more expensive than those on hilly terrain. Again it seems that the terrain is only part of the explanation for the variations in unit costs.

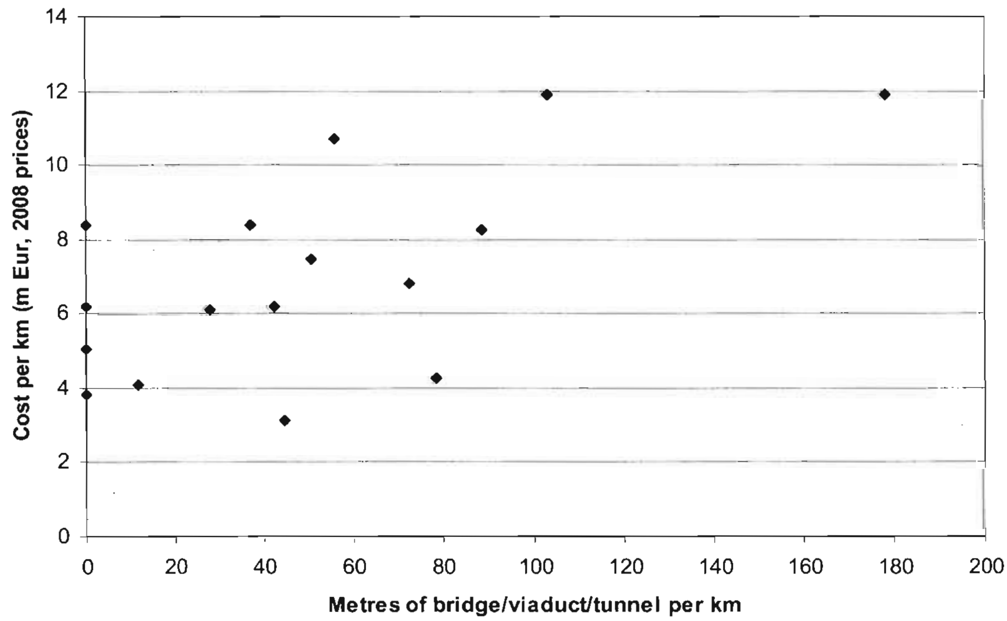
Although these results appear counterintuitive, there could be factors affecting this. The classification of the terrain relies on the information supplied on the fiches, and there may be some differences between countries in how the terrain has been classified. It may also be that as flat terrain is likely to be more densely populated this increases the costs due to factors such as the need for protective measures and relocation of utilities. It could also be that rivers in flat terrain are wider and hence require longer bridges.

Figure 2.20: Unit costs for new motorways or dual carriageways by length of scheme (mil Eur/km, 2008 prices)



Looking at the unit cost of building a new motorway compared with the length of the scheme, there does seem to be some tendency towards longer schemes being cheaper, indicating economies of scale. However again not all of the data fits this pattern

Figure 2.21: Unit costs for new motorways or dual carriageways by length of structures per km (mil Eur/km, 2008 prices)



The proportion of structures in a project does appear to influence the cost as would be expected, with the most expensive motorway projects having the highest length of structures per kilometre. However, whilst a trend can be seen for costs to increase as structures increase, the data is still very scattered and the length of structures cannot provide the full explanation for the ranges of costs seen. Projects where information was not supplied on the length of structures have been excluded from this figure.

The unit costs for new Motorways and dual carriageways again showed a wide range. Costs were similar within countries but showed considerable variation between countries.

2.4.4.3 National Road Rehabilitation

The unit costs for road rehabilitation are shown in Figure 2.22. Figure 2.23 shows the unit costs by the type of rehabilitation.

Figure 2.22: Distribution of unit costs for National road rehabilitation (mil Eur/km, 2008 prices)

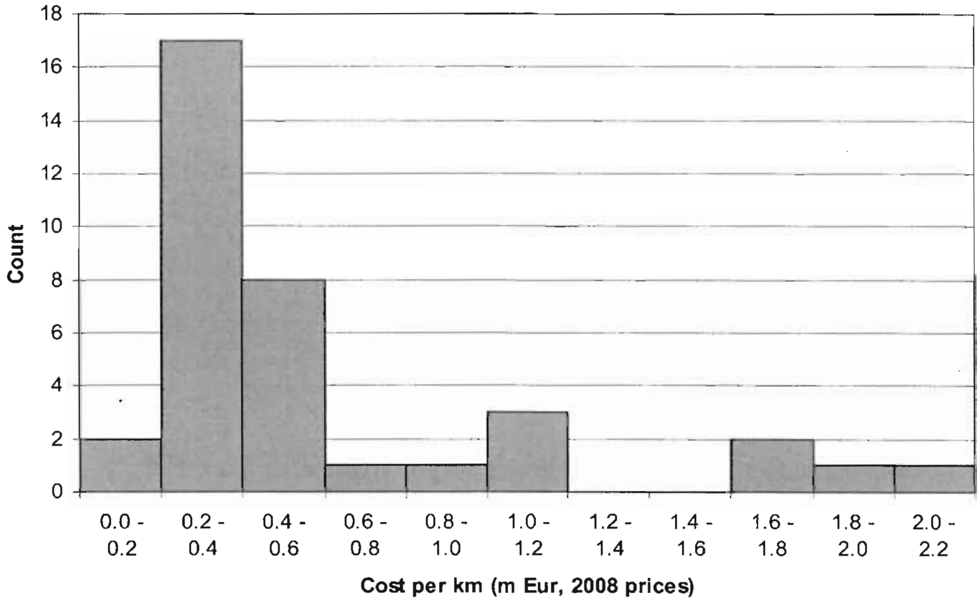
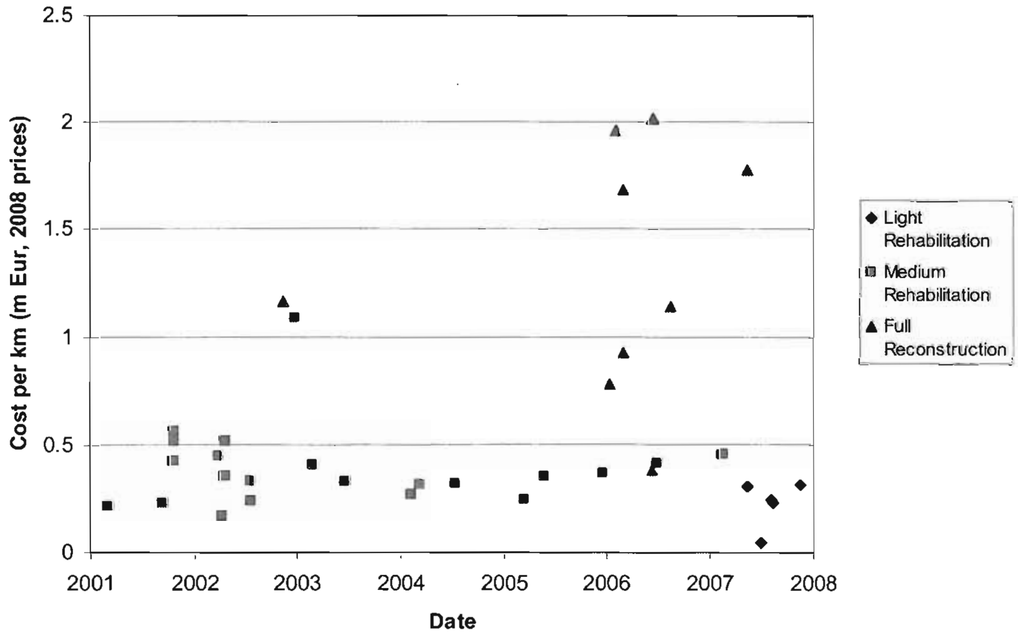


Figure 2.23: Unit costs for National road rehabilitation by type of rehabilitation (mil Eur/km, 2008 prices)



Projects ranged in cost from 0.05 to 2.02 million Euro per km. As would be expected, the projects involving full reconstruction generally had the highest unit costs and those involving only light rehabilitation the lowest unit costs. The ranges for each rehabilitation type are summarised in Table 2.16.

Table 2.16: Unit cost range (mil Eur/km, 2008 prices) by type of rehabilitation

Type of Rehabilitation	Minimum unit cost	Maximum unit cost
Light rehabilitation	0.05	0.31
Medium rehabilitation	0.17	1.09
Full reconstruction	0.38	2.02

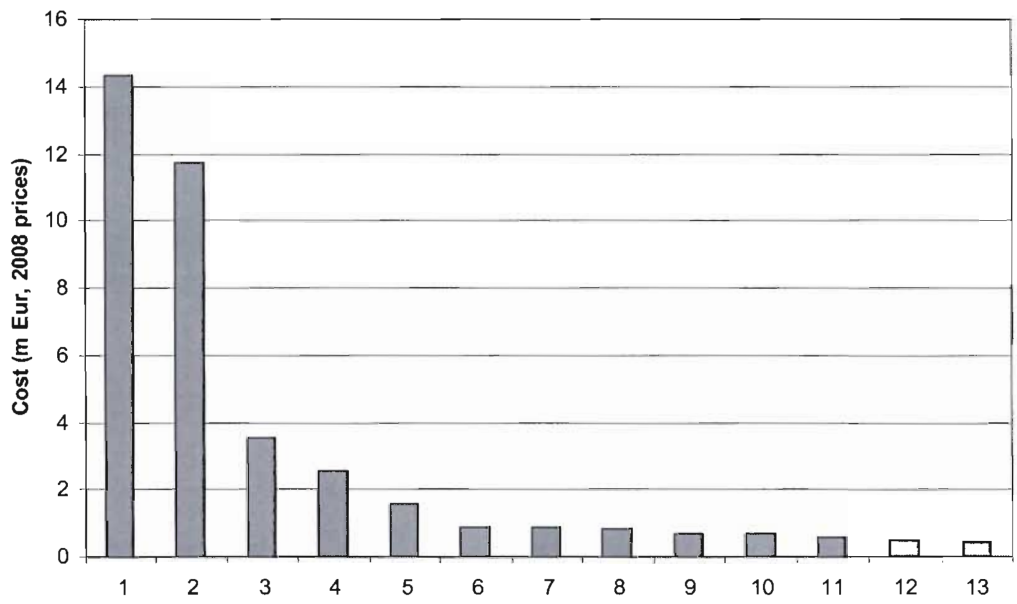
When divided into light rehabilitation, medium rehabilitation and full reconstruction, unit costs could be benchmarked to relatively narrow bands for each category.

2.4.4.4 Average unit cost for infrastructure components

<u>Bridges</u>

Figure 2.24 shows the unit cost for a bridge for each project where cost information on bridges was supplied.

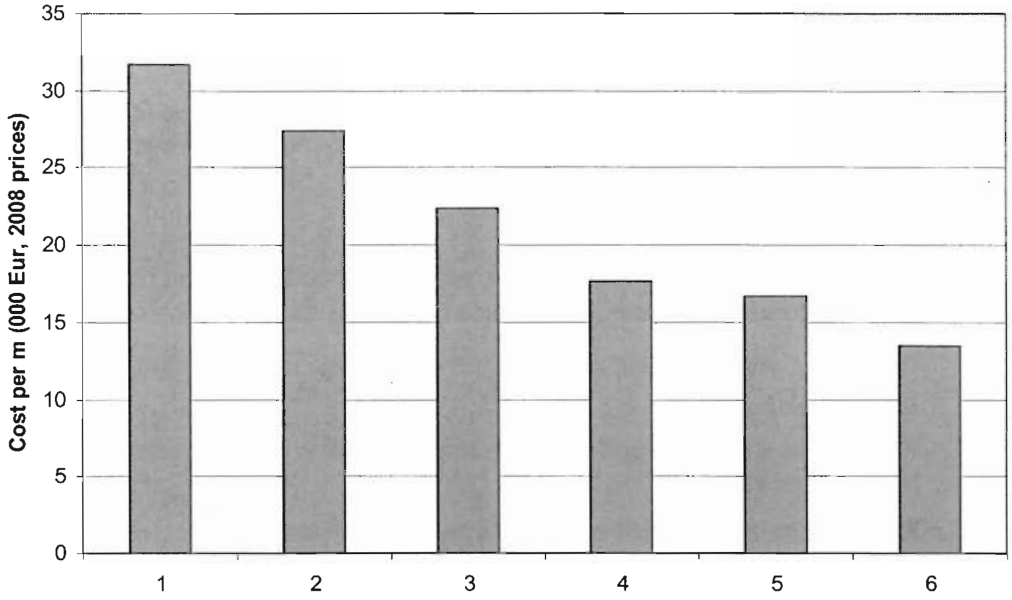
Figure 2.24: Bridge unit cost (mil Eur, 2008 prices)



A wide variation is seen in the unit cost of bridges from around 0.5 to over 14 million Euro at 2008 prices.

However, this analysis is limited as it does not reflect the varying lengths of the bridges constructed. Whilst this information was not supplied for all projects which included bridges, a further analysis was carried out where this information was available to produce a cost per metre of constructing a bridge. This showed that the two projects which had much higher bridge costs were based on just one longer bridge, whilst the other projects included several shorter bridges, explaining the wide range seen when analysed by the number of bridges. The analysis by length is shown in Figure 2.25.

Figure 2.25: Bridge unit cost per metre (000 Eur, 2008 prices)

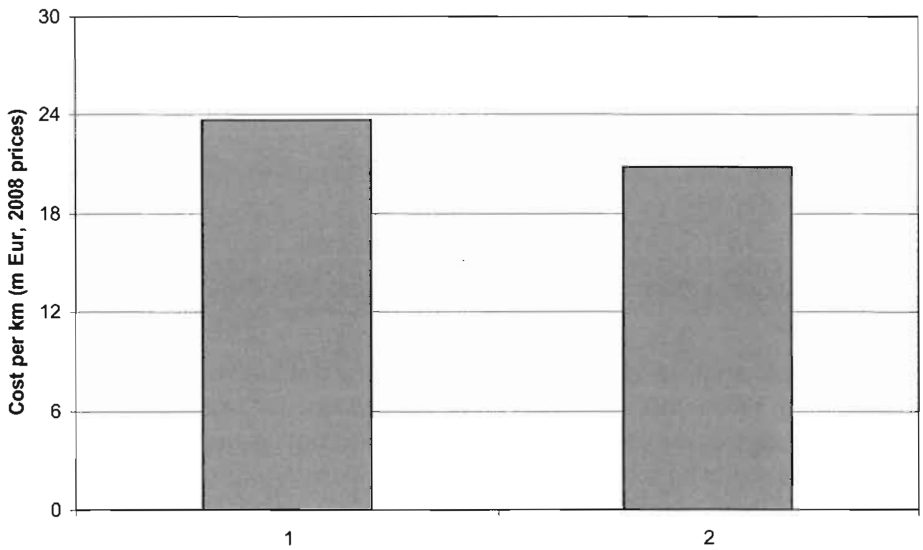


Although the sample is smaller when the data is analysed on this basis, this shows a narrower range of unit costs for bridges from around 14 to 32 thousand Euro per metre of bridge constructed.

Viaducts

Very limited information was available on the cost of viaducts from the projects included in Task 7. Figure 2.26 shows the viaduct unit costs per kilometre constructed.

Figure 2.26: Viaduct unit cost (mil Eur/km, 2008 prices)



Whilst only two data points were available with viaduct cost data, the unit prices were relatively consistent, giving a range of cost per kilometre in 2008 prices of between 20 and 24 million Euro.

Tunnels

Only one project included in the study provided cost information on a tunnel. This showed a unit cost per kilometre of tunnel constructed in 2008 prices of 25.5 million Euro.

2.4.5 Conclusions: Roads

2.4.5.1 Limitations of the database

The rather inconclusive results are the outcome of a long exercise constrained by the difficulty of obtaining reliable and consistent data. It is unwise to draw strong conclusions as the nine country database covers projects completed mainly over the period 2003 -2008 and contains only 19 new national road, 21 new motorway and 36 road rehabilitation contracts. Whilst efforts have been made to screen out non-standard projects, and the road rehabilitation category has been sub-divided, there can be no guarantee that, on account of the varying quality of descriptions provided by the beneficiaries, all design differences have been identified.

2.4.5.2 National Roads

The unit costs for new national roads show a wide range with a tendency for the unit cost to increase over time above the level of general inflation. This range of costs is not easily explained by the type of terrain, total length of scheme or length of structures.

The significance (measured by m/km) of structures does not appear to be a significant variable affecting outturn cost/km but this maybe a consequence of poor quality data.

The broad picture is one of overheating of the road construction sector especially over the period 2004-2007 with a collapse in prices in 2008-2009. Thus, the stage in the economic cycle when contracts are signed is an important consideration in explaining contract prices.

2.4.5.3 Motorways

The unit costs for new Motorways and dual carriageways again showed a wide range. This data set related to 21 contracts in five of the participating countries. The results showed a very wide range in unit costs, no increase (beyond general price inflation) over time but quite strong evidence that the variation in unit costs is much more marked between countries than within countries.

There is no evidence that terrain or scheme length influence unit cost and only very weak evidence of an effect caused by total length of structures (m/km). This general lack of evidence of three factors known to be relevant is most likely due to lack of robust data and the dominant effect of cost variation between countries.

As is the case for national roads, geographical variations *are* important. Motorways may generally be associated with more valuable contracts more likely to attract international contractors.

2.4.5.4 National Road Rehabilitation

This data set related to 36 contracts in six of the participating countries. In view of the wide variation in the scope of works it was deemed appropriate to sub divide this category into three sub-categories relating to light and medium rehabilitation and full reconstruction works. When divided in this way, unit costs could be benchmarked to relatively narrow bands for each category.

The three sub categories reflect different approaches to the treatment of road rehabilitation and reconstruction between countries with very little data enabling a comparison of the cost of the same type of treatment in different countries.

The data show an increase in cost as the level of treatment increases as would be expected. If one or two outlier points are excluded, the range in costs, especially of light and medium rehabilitation, is relatively narrow. The cost range of full reconstruction is significantly higher. This database would have to be strengthened to develop valid benchmarks for comparison between countries. Since rehabilitation works are not a prominent feature of the OPs and are typically carried out by local contractors, working under local contracts, it is suggested that this would not be a particularly useful exercise. In the case of rehabilitation, policy should be to encourage high levels of competition between the local contractors competing in each domestic market.

2.4.6 Potential Corrective Measures

One of the sub tasks within this task is to list potential corrective measures identified as a result of the analysis. The above analysis provides some useful pointers towards areas of concern. Under the general heading of potential corrective measures there should be a discussion with the MAs of the value of an ongoing Task 7 type exercise.

Clearly a more rigorous activity is required with a database of 3-400 projects minimum. This would need strong descriptions of each project (x carriageway and longitudinal cross sections as a minimum).

Overall project recommendations and potential corrective measures drawn from the evidence collated from Task 7 together with the other tasks are given in Chapter 4.

2.4.7 Propose a range of unit costs

A further sub task was to propose a range of unit costs to be used for cost estimating purposes during the 2007-2013 programming period. The ranges of unit costs produced are shown in Table 2.17. These results should be treated with caution. As stated above, sample sizes within each category were small and it was difficult to obtain reliable data. As a result, the ranges are wide. The ranges are narrowed by considering the quartiles and thus eliminating any outlying values.

Table 2.17: Range of unit costs (mil Eur/km, 2008 prices)

Project Type	Minimum unit cost	Maximum unit cost	Quartiles (25/50/75%)
New National road	1.1	6.0	1.9/ 2.7/ 4.2
New Motorway	2.3	11.9	4.1/ 6.2/ 8.2
Light Rehabilitation	0.1	0.4	0.1/ 0.2/ 0.3
Medium Rehabilitation	0.1	1.1	0.3/ 0.4/ 0.4
Reconstruction	0.3	2.1	0.8/ 1.2/ 1.7

As discussed previously, unit costs vary considerably between countries. Producing benchmarks for each country separately may be more meaningful, but this would require a much stronger database to have adequate sample sizes for each country. Currently there are several countries where one or more of the above project types would have a range of unit costs based on only one or two projects.

2.4.8 Compare to costs in OP

One of the stated objectives was to apply the calculated unit costs on the projects included in the OP and provide comments for possible major discrepancies between the project's cost estimation in the OP and the project cost estimation based on the applied unit values.

Whilst a range of unit costs has been produced, it has been shown that there is considerable variation between countries in the unit costs. Taking the range of benchmark costs for all nine countries combined and applying this to the individual OPs may not give a useful result if the particular country the range is being applied to tends to have particularly high or low costs. However, given the small sample sizes for each country, applying specific ranges for each of the nine countries individually is also not likely to be meaningful.

The projects included in these unit cost ranges were all completed between 2003-2008, and given the collapse in prices over the past two years, it may not be relevant to use projects from this period to estimate the costs of projects due to be implemented in the next few years.

The range of costs is also very wide and therefore not likely to give a helpful indication of OP output. Taking national roads as an example, if the range of unit costs was applied to the OP budget to produce an estimate of the kilometres that could be built using OP funds, the high estimate would be five times that of the low estimate. This would not therefore show a very clear picture of the quantity of new national roads that could be constructed in the OP.

The OPs are also not very specific about technical characteristics of the projects included, such as the length, amount of structures included and the type of terrain the project will be built on. This prevents the meaningful application of benchmarks.

However the process and databases of about 100 road projects are important outputs from the Study and could form the basis of an ongoing exercise to develop benchmarks for unit costs (and cost development) as well as monitoring project outcomes.

The OPs may be linked more realistically to cost development than to cost benchmarking although, here again, ideally it would be better to compare projects appraised and procured at the same stage in the economic cycle. Projects included in the OPs are typically at different stages of development, with some countries tending to present projects that are well advanced in terms of design whereas in other cases, the projects presented may be at earlier stages of development. This range in the maturity of projects also complicates the picture and makes it difficult to generalise and development standard cost development ratios from the current database of projects.

Against this background, the results, shown in Table 2.9, indicate, on average, a 10% cost overrun from appraisal to final outturn cost. If this were applied to the projects in the OP, then the final outturn costs would actually be 10% higher on average than the costs given in the OP. Any cost overrun would need to be funded by the beneficiary or from the national budget. This would be in addition to the 15-20% of the decision amount (depending on the co-financing rate) plus ineligible costs funded locally. In reality therefore, the local authorities may need to contribute, on average, as much as 25-30% of the OP cost once cost overruns are included.

The above comments are based on the average cost development factor (Table 2.9) of 10%. The results show a very high standard deviation about this average, so that especially in the smaller countries with only a relatively small number of contracts let each year, there may be substantially higher levels of overrun experienced. Depending upon contract arrangements, it will not normally be possible for savings in under-running projects to be captured by the public authorities and used to fund overruns elsewhere. Thus,10% is likely to be a minimum rather than an average figure which should be provisioned for.

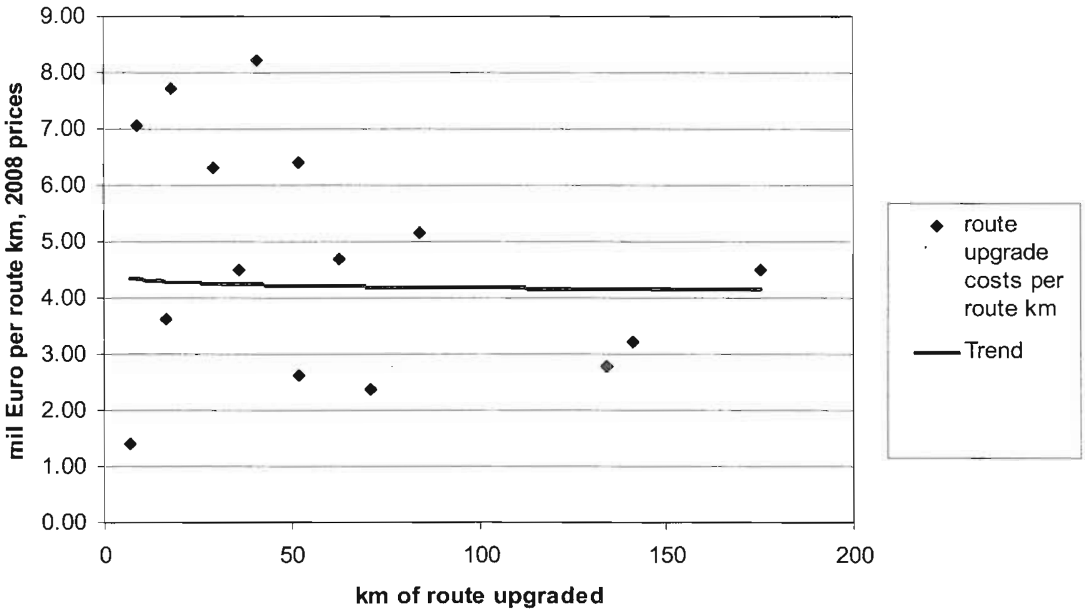
2.4.9 Results Rail

2.4.9.1 Route Upgrade Cost

Route upgrade means a renewal of track, signalling and overhead line equipment (OLE) with a consequent increase in speed and axleload capability of the route. This is generally route refurbishment, and there are no schemes included which involve new construction. Nevertheless the components of each scheme vary significantly.

Figure 2.27 shows the cost of route upgrade per route kilometre. The route upgrade cost is based on the total project cost excluding VAT and including costs such as land and site preparation.

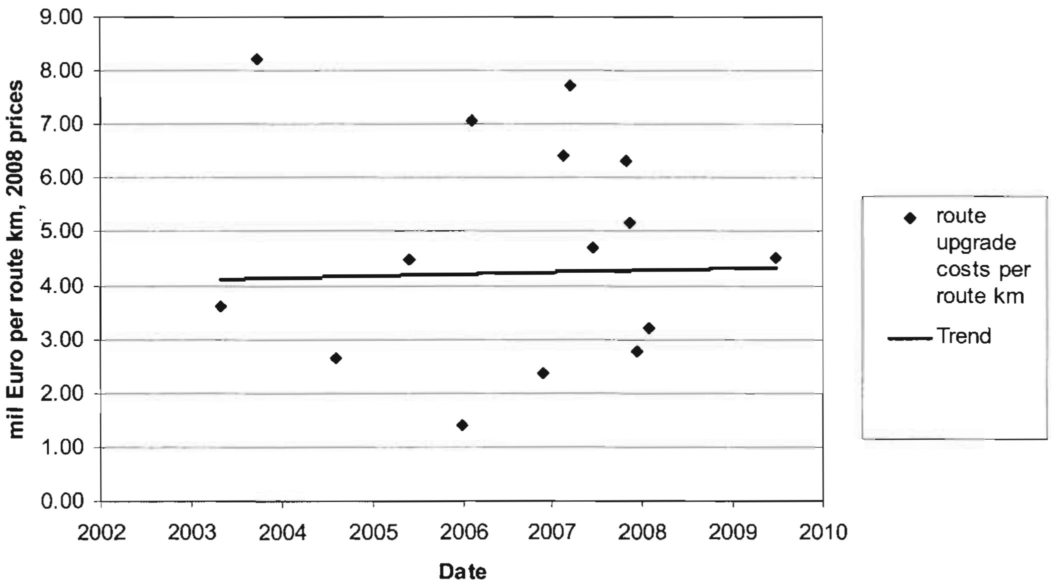
Figure 2.27: Route upgrade cost (mil Euro per route km, 2008 prices)



This shows a wide range of route upgrade costs, from 1.4 to 8.2 million Euro per route km at 2008 prices. The results do not show a relationship between the unit cost and the total length of route upgraded.

A further analysis of the data by time was carried out as shown in Figure 2.28.

Figure 2.28: Route upgrade cost by time (mil Euro per route km, 2008 prices)

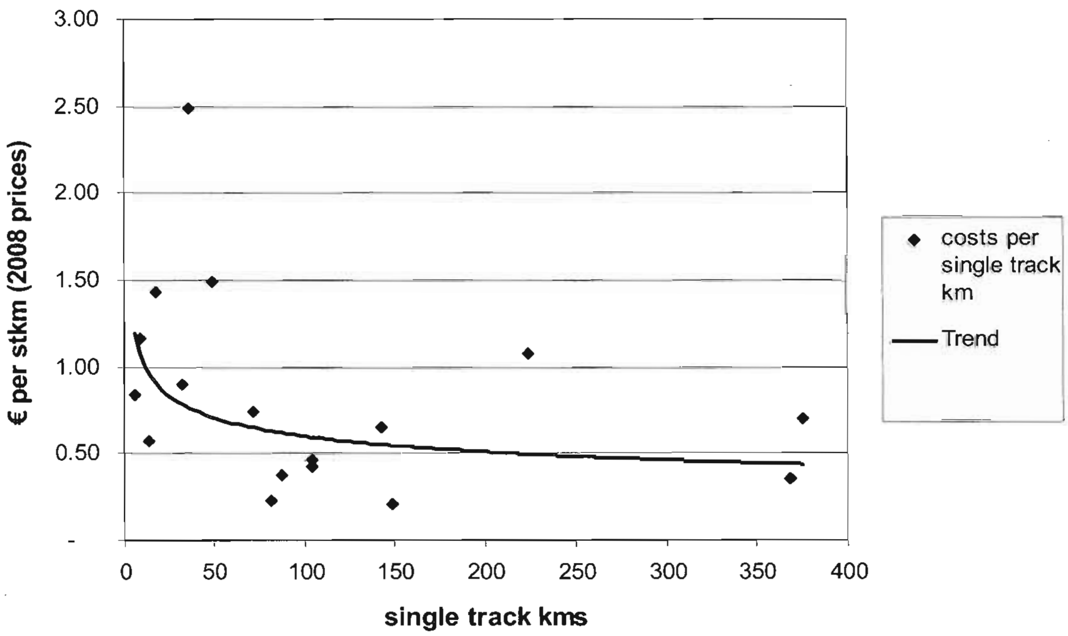


When considering the dataset as a whole by the time period, there is no clear trend with a large degree of scatter of the data. There is however considerable variation by country. A general upward trend in costs over time can be seen within most countries. With the limited data available this does indicate that there may have been some tendency for costs to increase above the level of general inflation for route upgrade.

2.4.9.2 Permanent Way Cost

An analysis has been carried out of the element of project costs taken up with track renewal. It includes the costs for track renewal only and VAT has been excluded. The unit cost has been calculated using the length in single track kilometres which has been renewed.

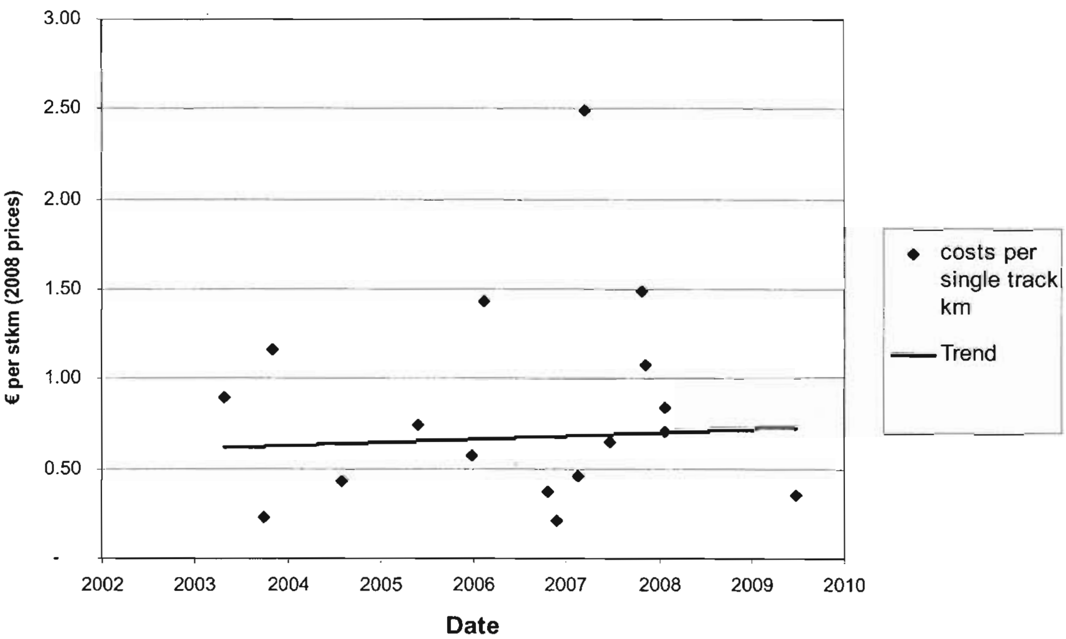
Figure 2.29: Permanent way cost (mil Euro per single track km, 2008 prices)



This shows some relationship between the unit cost per single track km and the total single track length renewed, with unit costs lower the longer the length of track renewed. However, this relationship is not particularly strong. Unit costs for permanent way ranged from 0.2 to 2.5 million Euro per single track km at 2008 prices. However, one project was noticeably higher in cost than the others, with the upper end of the range being 1.5 million Euro if this project was excluded.

An analysis of the data by time was also carried out to give further understanding of the results.

Figure 2.30: Permanent way cost by time (mil Euro per single track km, 2008 prices)

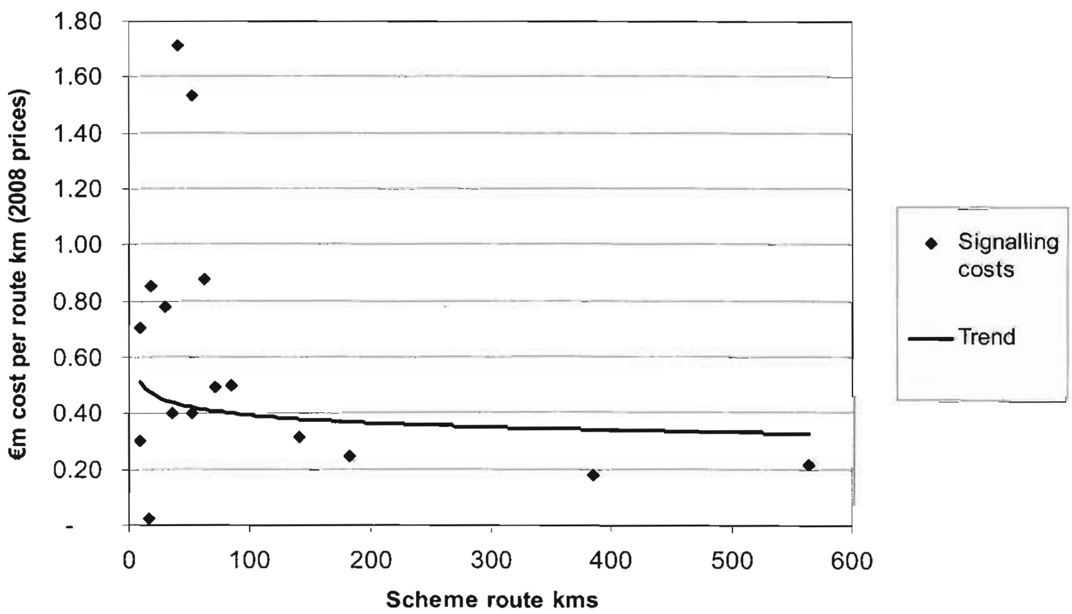


As for route upgrade, the data shows considerable scatter and whilst there is some upward trend in cost over time the pattern is not clear.

2.4.9.3 Signalling Cost

An analysis has been carried out of the signalling costs where they have been included in projects. These costs are based on the signalling and telecoms costs only and VAT has been excluded. The costs are difficult to analyse as the data supplied is relatively high level. As a result, the only comparator which can be used is the length in route kilometres. This ignores the number of sidings, loops, junctions, bi-directional working etc, which has a significant influence on project costs. The results of the analysis are shown in Figure 2.31.

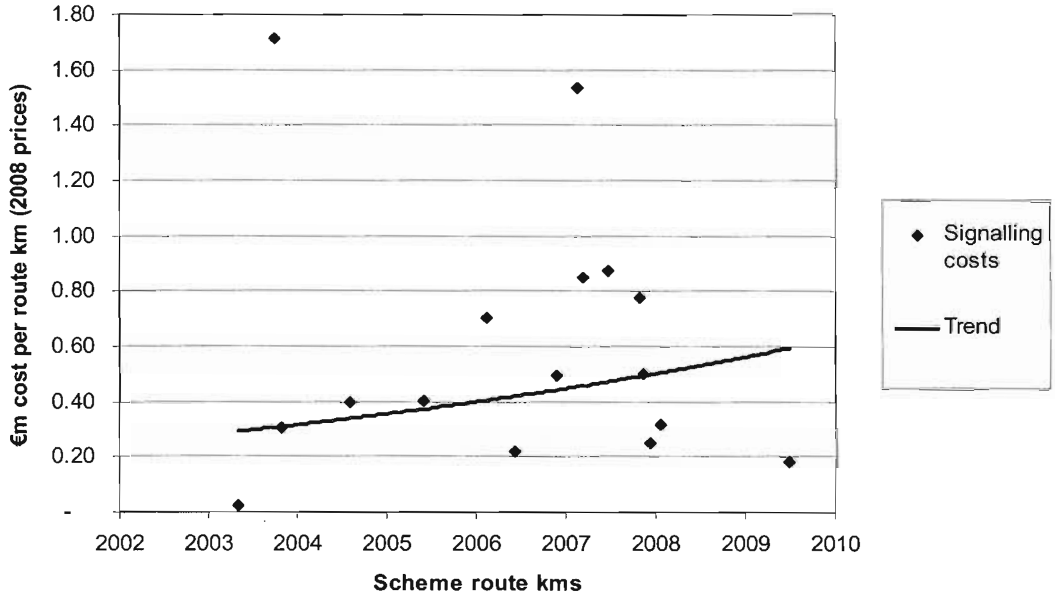
Figure 2.31: Signalling cost (mil Euro per route km, 2008 prices)



This shows some trend for the signalling unit cost to decrease with route distance. However, a couple of short projects with low signalling unit costs weaken this relationship. The range of unit costs is from under 0.1 to 1.7 million Euro per route km at 2008 prices.

The signalling costs were further analysed by time as shown in Figure 2.32.

Figure 2.32: Signalling cost by time (mil Euro per route km, 2008 prices)

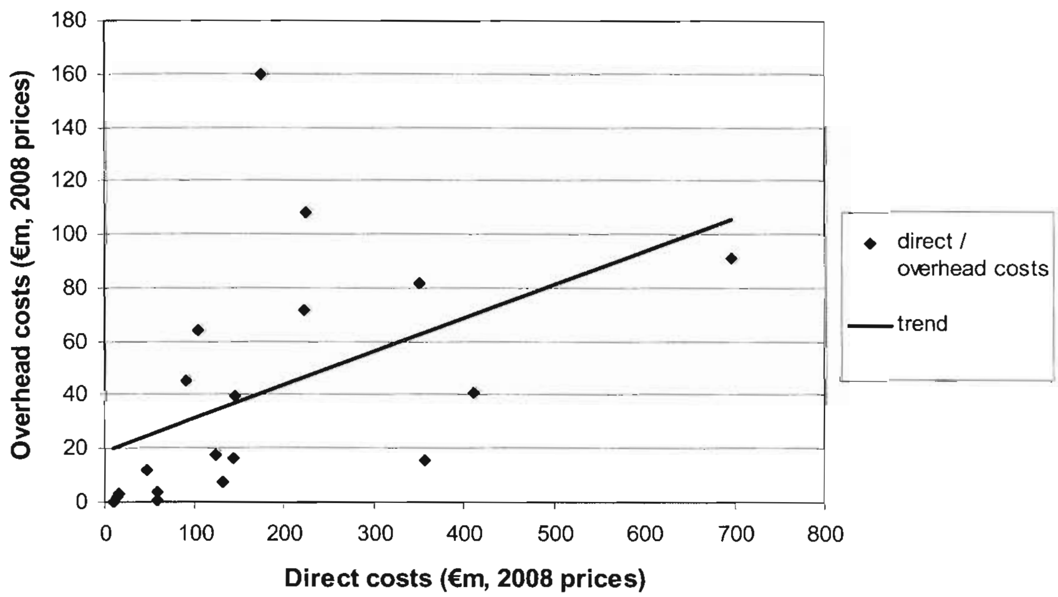


There is a slight upwards trend in cost over time.

2.4.9.4 Relationship between direct and overhead costs

The amount of overhead costs in relation to the direct project costs has been compared as shown in Figure 2.33.

Figure 2.33: Relationship between direct and overhead costs (mil Euro, 2008 prices)



This analysis shows that there is a trend for overhead costs to increase as the direct costs of the project increase. Some projects show very high overhead costs in relation to the direct costs. This may reflect issues with how the costs have been presented in the project fiches. It may also reflect some projects being more complex to design than others or having greater land requirements.

2.4.10 Conclusions: Rail

2.4.10.1 Limitations of the database

The inconclusive results are the outcome of a long exercise constrained by the difficulty of obtaining reliable and consistent data. The exercise was also limited by a relatively small number of rail projects carried out in the participating countries in the time period considered. Whilst efforts have been made to remove projects which are not suitable for comparison, the varying quality of information provided by the beneficiaries means that there may be some projects of this nature which were not screened out.

There were further difficulties in assessing the total scope of each of the projects from the data provided, as there was no direct comparison of either the project outputs or the initial asset condition which would have a significant impact on project cost, timescale and potential risk.

There is some reason to suspect that different countries apply different project build-up methodologies, and that the scope of works included in project costs or counted as general rail overheads may vary as standard practice between countries. We have little data to support this but it would go some way towards explain the significant variations between countries for superficially similar project scopes.

2.4.10.2 Route Upgrade

The unit costs for route upgrade show a wide range of unit costs with no clear trend relating to the length of route upgraded.

2.4.10.3 Permanent Way

This dataset related to 17 contracts in six of the participating countries. The unit costs for permanent way again showed a wide range. There was not a clear pattern between countries. The results show some tendency for longer projects to have cheaper unit costs but no clear pattern of changes in cost over time.

2.4.10.4 Signalling

Signalling unit costs also showed a wide range, with variations between countries.

One country (SK) had notably higher costs than the other countries. Another country (POL) also tended to have slightly higher costs though this may relate to scheme length. A trend was seen of costs increasing over time in two countries (CZ and POL).

This dataset related to 16 contracts in six countries.

2.4.11 Sub-task (iv) : pPotential corrective measures

One of the sub tasks within this task is to list potential corrective measures identified as a result of the analysis. The above analysis provides some useful pointers towards areas of concern.

The database is very limited in size, making it difficult to make meaningful comparisons between countries. There would be value in collecting data for all projects in the future, allowing a much larger database to be compiled and providing the basis for more robust estimates of unit costs.

It would be particularly important to have more detailed descriptions of the projects, including information on the scope of the project in terms of outputs and the initial asset condition, to ensure that the projects are comparable.

2.4.12 Propose a range of unit costs

A further sub task was to propose a range of unit costs to be used for cost estimating purposes during the 2007-2013 programming period.

The ranges of unit costs produced are shown in Table 2.18. These results should be treated with caution. As stated above, sample sizes within each category were small and it was difficult to obtain reliable data. As a result, the ranges are wide.

Table 2.18: Range of unit costs (mil Eur/km, 2008 prices)

Project Type	Minimum unit cost	Maximum unit cost	Quartiles (25/50/75%)
Route upgrade (per route km)	1.4	8.2	2.7/ 4.5/ 6.3
Permanent way (per single track km)	0.2	2.5	0.4/ 0.7/ 1.0
Signalling (per route km)	0.02	1.7	0.2/ 0.4/ 0.8

Route kilometres relate to the overall length of route, while single track kilometres relate to the actual length of track within the route section, which may be double or single. There is therefore no direct relationship between the two figures, as some routes have more double or single track than others. The objective of the analysis was to identify if there were visible trends for either set of data which could be used to produce guide benchmark figures.

2.4.13 Compare to costs in OP

One of the stated objectives was to apply the calculated unit costs on the projects included in the OP and provide comments for possible major discrepancies between the project's cost estimation in the OP and the project cost estimation based on the applied unit values.

Whilst a range of unit costs has been produced, it has been shown that there is considerable variation between countries in the unit costs. The difficulties in establishing if the projects had comparable scopes also meant that applying the outputs of the benchmarking exercise to the OP budgets would not be very meaningful.

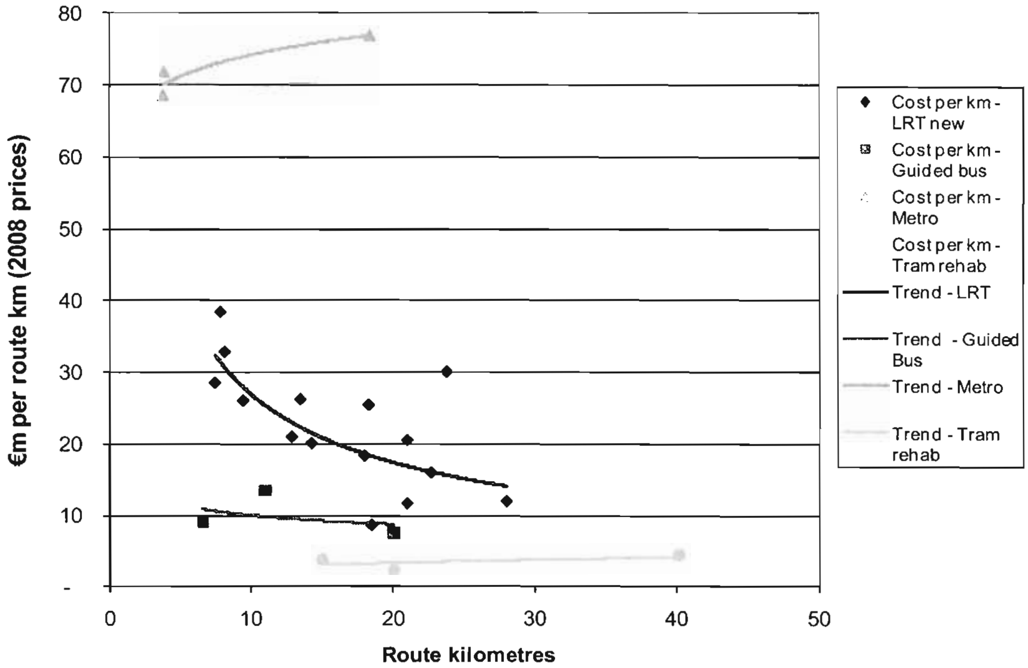
Section 2.4.8 discusses further the difficulties of comparing to the costs in the OP.

2.4.14 Results: Urban Transport

2.4.14.1 Infrastructure cost

Infrastructure costs were based on the total project cost excluding the cost of rolling stock. An analysis of the infrastructure costs per route kilometre by type of technology and length of route is shown in Figure 2.34.

Figure 2.34: Infrastructure cost (mil Euro per route km, 2008 prices)

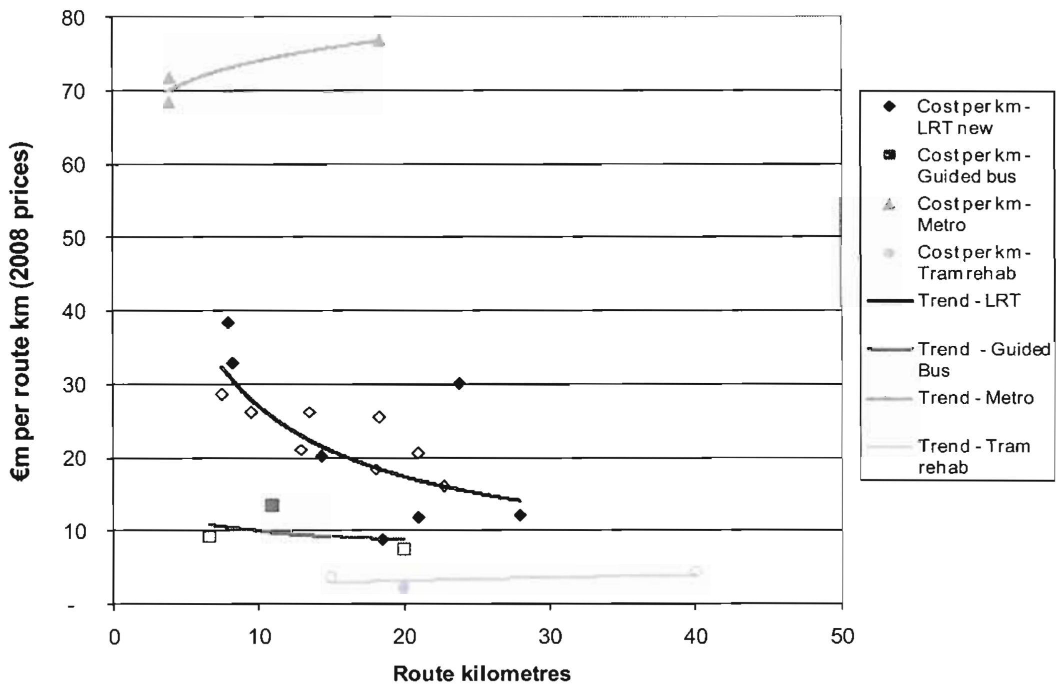


There are clear differences in the unit cost of infrastructure depending on the type of technology used, as would be expected. Metro systems are the most expensive, showing much higher costs per kilometre than LRT or guided bus systems. This is due to the wider gauge cost of constructing underground lines. Unit costs for Metro infrastructure range from 68 to 77 million Euro per km at 2008 prices, compared with 9 to 38 million Euro per km for new LRT infrastructure and 8 to 13 million Euro per km for guided bus infrastructure. Unit costs for tram rehabilitation range from 2 to 4 million Euro per km.

Length of the route appears to have some influence on the cost for new LRT infrastructure, with longer routes having lower unit costs. One of the more expensive projects in Dublin does not fit so well with this trend, but the high costs of Dublin were due in part to high local construction cost inflation and high land costs due to the booming property market at the time.

In Figure 2.35, the points shown as solid points represent the projects where a completion report or cost at or near completion was available. The projects for which only an appraisal report or early stage cost estimate was available are shown as unfilled points.

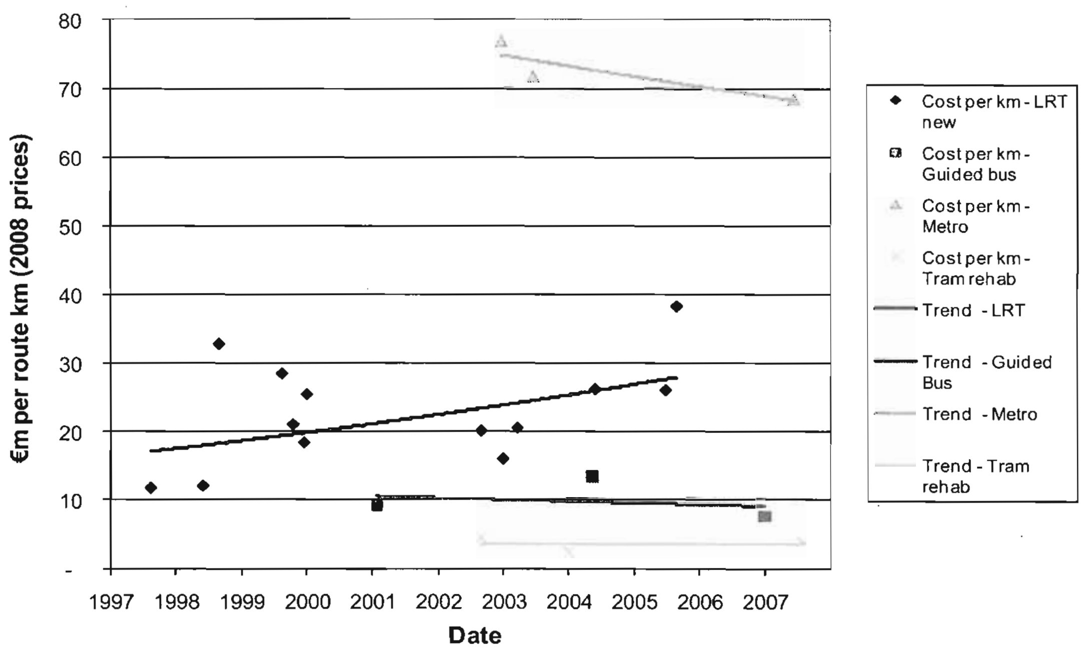
Figure 2.35: Infrastructure cost – points shown as outlines only represent projects where only an Appraisal Report was available (mil Euro per route km, 2008 prices)



Only LRT has enough data points to be able to analyse the effect of including projects for which only a cost at appraisal was available. The unit costs for projects where only the appraisal cost was available are more clustered, ranging from 16 to 29 million Euro/km compared with 9 to 38 million Euro/km for the projects for which a final cost was available. There is a wider variation looking only at those projects with outturn costs. As all of the datapoints where a cost at appraisal was used fall within the range of the costs for projects which had a final cost, it appears that including these projects in the database has not altered the overall result.

A further analysis of the data by time (based on the date at the midpoint of the construction period) was carried out as shown in Figure 2.36.

Figure 2.36: Infrastructure cost by time (mil Euro per route km, 2008 prices)

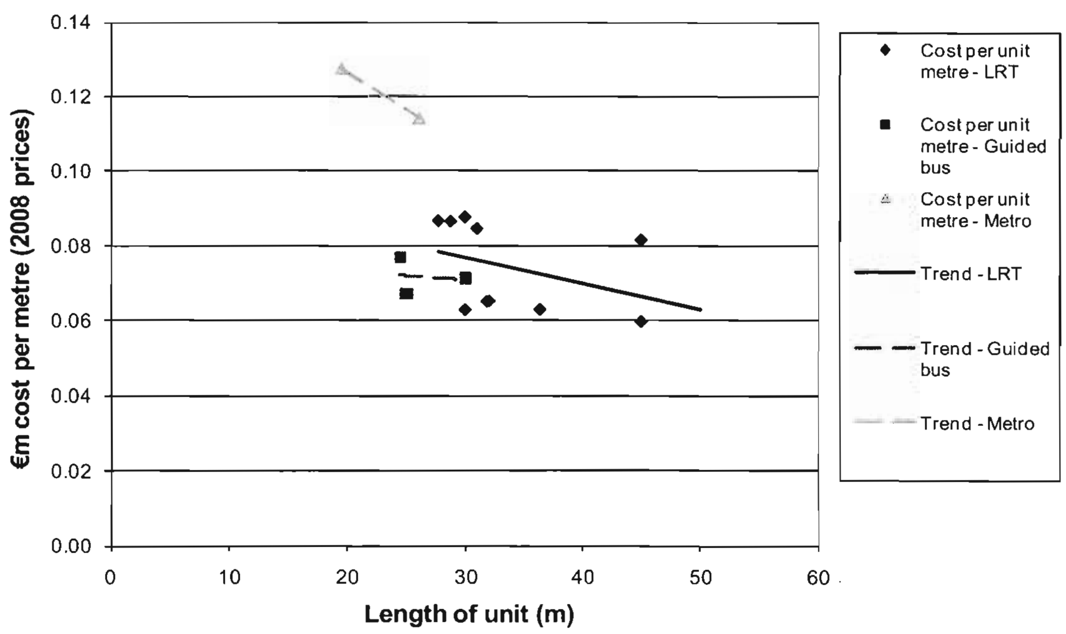


For new LRT, unit costs of infrastructure appear to have increased slightly above the rate of general inflation over time. There seems to have been some downward trend in Metro unit costs over time, though the limited sample makes it difficult to make a reliable judgement.

2.4.14.2 Rolling stock cost

Rolling stock costs have been taken from appraisal reports as detailed breakdowns of costs were not given in the project completion reports. Costs per vehicle unit metre have been estimated by dividing the rolling stock cost by the number of vehicles and vehicle length.

Figure 2.37: Rolling stock cost (mil Euro per vehicle unit metre, 2008 prices)

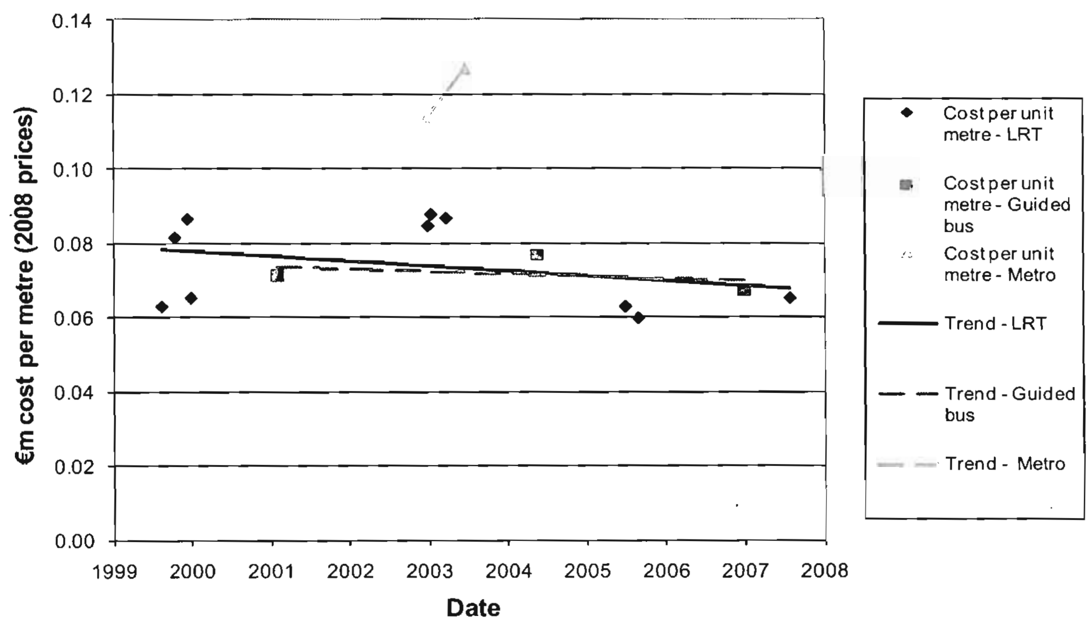


Metro projects had the highest cost per vehicle unit metre as they did for infrastructure and as would be expected. The costs ranged from 114 to 127 thousand Euro per unit metre in

2008 prices. LRT and guided bus projects had similar vehicle unit costs, with LRT ranging from 60 to 88 thousand Euro and guided bus from 67 to 77 thousand Euro per unit metre.

An analysis of the data by time was also carried out but this did not suggest any clear trend over time in rolling stock cost.

Figure 2.38: Rolling stock cost by time (mil Euro per vehicle unit metre, 2008 prices)



2.4.15 Conclusions: Urban Transport

2.4.15.1 Database: Caveat

This exercise was limited by the lack of sufficient urban transport projects carried out in the participating countries in the time period considered. An analysis has therefore been carried out using urban transport projects across Europe.

2.4.15.2 Infrastructure

This data set related to 24 contracts across 9 European countries. The results showed clear differences in unit costs depending on the type of technology used, with Metro being the most expensive and guided bus the cheapest for new infrastructure. New LRT schemes showed a wide range of unit costs, with a tendency for longer schemes to be less expensive. As would be expected, LRT rehabilitation schemes had the lowest unit costs.

2.4.15.3 Rolling stock

For rolling stock, a total of 15 contracts were analysed, made up of projects from 7 countries.

The results show similar vehicle unit costs for LRT and guided bus, with Metro vehicles having a higher unit cost. There is no clear relationship between the vehicle unit cost and the total length of the vehicle or a change in the unit costs over time.

2.4.15.4 Potential corrective measures

The above analysis is comprised of projects across Europe, with few in the nine participating countries, therefore it is not possible to draw conclusions on potential corrective measures in the area of urban transport.

However, as a general recommendation it would be useful to consider an ongoing Task 7 type exercise in order to compile a larger database with more projects in the nine countries.

2.4.15.5 Propose range of unit costs

A further sub task was to propose a range of unit costs to be used for cost estimating purposes during the 2007-2013 programming period.

The ranges of unit costs produced are shown in Table 2.19. These results should be treated with caution. As stated above, sample sizes within each category were small. As a result, some of the ranges are wide. However, they may give a useful guide to the participating countries as to the likely magnitude of costs that may be expected for any future urban transport projects.

Table 2.19: Range of unit costs (mil Eur/km, 2008 prices)

Project Type	Minimum unit cost	Maximum unit cost	Quartiles (25/50/75%)
Metro infrastructure (per route km)	68.4	76.8	
LRT infrastructure (per route km)	8.7	38.4	14.9/ 20.9/ 27.0
Guided bus infrastructure (per route km)	7.5	13.5	
LRT infrastructure rehabilitation (per route km)	2.3	4.5	
Metro rolling stock (per unit metre)	0.11	0.13	
LRT rolling stock (per unit metre)	0.06	0.09	0.06/ 0.07/ 0.09
Guided bus rolling stock (per unit metre)	0.07	0.08	

As the range of unit costs is based mainly on Western European countries, Eurostat[19] figures have been used to adjust the ranges to be applicable to the nine Eastern European countries considered in the CFPM study. The average price level for the 24 projects included in the unit cost ranges based on the civil engineering works index for the country in which they were carried out is 116.2. The average civil engineering works index for the nine CFPM countries is 97.3. The infrastructure unit cost ranges adjusted using these indices are shown below.

Table 2.20: Range of unit costs adjusted for CFPM countries based on Eurostat data (mil Eur/km, 2008 prices)

Project Type	Minimum unit cost	Maximum unit cost
Metro infrastructure (per route km)	57.3	64.3
LRT infrastructure (per route km)	7.3	32.2
Guided bus infrastructure (per route km)	6.3	11.3
LRT infrastructure rehabilitation (per route km)	1.9	3.8

[19] "Wide spread in construction prices across Europe in 2007", Eurostat Statistics in focus 114/2008

3 Review of Current Practice

3.1 Scope of Work

This chapter reviews current practice in the participating countries in cost estimation, risk management, use of price adjustment clauses, value engineering and the budgeting process. Examples of good practice and recommendations are set out in Chapter 4.

3.2 Task 8: Cost Estimation

3.2.1 Objectives

The broad aim of Task 8 was to review the cost estimating methodologies used on major road and rail infrastructure projects in order to propose improvements. The specific objectives were:

- Review and comment on existing cost estimating methodologies in the participating countries, particularly any prescribed industry standards;
- Review past performance with regard to accuracy of estimation compared to contract prices and final outturn costs;
- Identify potential deficiencies in the methodology and propose improvements;
- Review one sample estimate for a major project application to the EU per country and advise on its likely accuracy based on the results of other sub-tasks.

Poor quality cost estimates can mean that the Employer is poorly advised and is potentially in a weak position when assessing bids, with the result that they may accept an unrealistically low bid. In addition, if poor quality cost estimates are combined with poor quality tender documents the Employer can easily be exploited by the Contractor and there can be significant potential for cost overruns. Thus, there can be acute budgeting problems with the budget allocation being insufficient.

3.2.2 Scope

A combined Task 5 and 8 report has been prepared for each participating country. This overview report aims to consolidate the main observations and common themes from the individual country reports.

The geographical scope of this review covers nine countries with the beneficiary organisations as set out in Table 3.1 below.

Table 3.1: Road and rail sector beneficiaries

Country	Sector	Participants
Slovakia	Rail	Slovakia Rail Administration; Technic Slovakia
	Road	Slovakia Roads Administration; Technic Slovakia
Poland	Rail	Polish Railway Lines
	Road	Poland Roads Administration GDDKiA
Romania	Rail	Romania Railways CFR; Feroviar
	Road	Romania Roads Administration RNCMNR
Latvia	Rail	NA
	Road	Latvian State Roads
Lithuania	Road	Lithuanian Roads Administration; Lithuanian Research Institute
	Rail	Lithuanian Railways
Estonia	Road	Estonian Roads Administration
Slovenia	Road	DARS Motorway Company; DDC Consulting
Czech Republic	Road	Czech Republic Road Administration
	Rail	Czech Republic Railway Infrastructure Administration
Bulgaria	Road	National Road Infrastructure Agency (NRIA)
	Rail	National Rail Infrastructure Company (NRIC).

3.2.3 Methodology

3.2.3.1 Data collection

For Task 8 we required either a description or specific examples from each country of their respective methodology used to develop cost estimates to allow us to make an informed comparison between them and accepted best practice. Following this we identified the likely consequences resulting from the particular methodologies/approach to producing cost estimates and proposed improvements if required/appropriate.

3.2.3.2 Approach

Our approach to Task 8 involved a thorough desk review of the current cost estimating approach adopted by the participating countries (where data were available). Further work for this task entailed in-depth local engagement with project participants within the participating countries.

3.2.4 Results

3.2.4.1 Introduction

Project cost escalation is a major problem for government agencies and potential funders of construction projects/programmes. Over the time span between the initiation of a project and the completion of construction many factors influence a project's final costs.

During the early stages of a project many factors that influence project costs are not known, in addition there are also other process type factors that often drive project cost estimate increases, for instance:

- Inadequate cost estimating methodologies;
- Lack of allowance for inflation;
- Lack of sufficient contingency allowance
- Scope changes;
- Time delays between feasibility and the production of tender documents

Traditionally, estimating project construction cost has been based on a combination of listed items with quantities and unit rates. Using a system of measurable units, whether they are cubic metres of concrete, kilometres of highway pavement, or kilometres of railway tunnel, the total project cost is based on assigning a unit cost to each of the planned items involved in the final construction. This is conventionally called the 'base' project cost estimate. A contingency sum is usually added to the estimate to take account of any unknowns. Typically, the contingency value is a percentage of the total unit cost estimate or base cost. The contingency is often based solely on judgement or historical experience from similar projects. In our experience rarely, except on some very large projects, are the individual risks and opportunities quantified explicitly.

Essentially, the cost estimate is based on a defined or assumed set of quantities and a specification for the works. The greater the accuracy in the quantification and specification, the greater the accuracy of the estimate. However, it should be noted that a cost estimate is a forecast of cost. It relies upon judgment and the use of empirical data to assess the likely final cost of a project. It may include or exclude a risk allowance. Most importantly, an estimate is not a fixed figure and may be subject to continual review as project objectives, constraints or risks change.

This review was looking for evidence that a structured process was in place in the participating countries for estimating the capital cost budget for major infrastructure projects. More specifically:

- Were there standard national guidelines for producing cost estimates on road or rail infrastructure projects?
- At what project stages were cost estimates produced?

- Who was responsible for producing the cost estimates at each of the project stages?
- What type of cost estimating methodology was employed at each of the project stages?
- What source of cost data was used to provide the estimates at each of the project stages?
- Were cost estimates developed incrementally, that is at each of the project stages?
- Were contingencies considered at each of the project stages?
  - How were contingencies included on the project?
  - What percentage was included for contingencies?
- Were the cost estimates independently verified at each project stage?

3.2.4.2 Past performance with regard to accuracy of estimation compared to contract prices and final outturn cost

Our review has highlighted evidence of cost increases on some of the projects considered, which are likely to be the result of a number of factors. Following our review we believe part of any cost increases may be the result of inadequate cost estimating methodologies currently employed in the countries reviewed. In particular, early stage estimates were considered to be relatively unreliable (even by the participants themselves).

3.2.4.3 Cost estimating methodologies in the participating countries

Following our individual country reviews, Table 3.2 below provides a summary of our observations regarding the cost estimation methodologies adopted in each participating country by sector.

Our results suggest that cost estimates produced at the early stage of the project lifecycle (in particular, at project appraisal) were relatively inaccurate and the process for cost estimating during the early stages of a project should be reviewed to ensure greater accuracy going forward.

3.2.4.4 Review of sample estimate for a major project application to the EU

From the sample estimates that we reviewed, it appears that one of the main reasons for cost overruns is likely to be the lack of adequate contingency allowances in early stage cost estimates. We believe that further consideration should be given to the provision of adequate contingency allowances at all project stages by the Beneficiaries more generally.

Table 3.2: Cost estimation methodologies – summary

Country	Sector	Are there Standard national guidelines for cost estimating available?	Are these mandatory?	Is there are a recognised data source for producing cost estimates?	Responsibility for production of cost estimates	Are cost estimates independently verified at each stage?	Are contingencies considered?
Slovakia	Rail	Yes	No	No	External consultants	No	Yes - to procurement stage only
	Road	Yes	No	No	External consultants	No	Yes
Poland	Rail	Yes	No	Yes	External consultants	Yes	Yes - but no separate allowance
	Road	Yes	No	Yes	External consultants	Yes	No evidence
Romania	Rail	No	NA	No	External consultants	Yes	Yes
	Road	No	NA	No	External consultants	No evidence	Yes
Latvia	Rail	Yes	No	No	External consultants	No	No
	Road	Yes	No	Yes (under development)	External consultants	No evidence	Yes
Lithuania	Road	Yes	No	No	External consultants	No	Yes
	Rail	Yes	Yes	Yes	External consultants	No	No evidence
Estonia	Road	Yes	No	Yes (under development)	External consultants	No	Yes
Czech Rep	Road	Yes	No	Yes	External consultants	Yes	Yes
	Rail	Yes	No	Yes	External consultants	Yes	Yes
Slovenia	Road	Yes	No	Yes	External consultants - but early estimates in house	Tender estimate stage only	Only for investment programme
Bulgaria	Road	No	No	No	External Consultants	No	Yes
	Rail	No	No	No	External Consultants	Yes	No

3.2.5 Recommendations

Cost estimates are central to establishing the basis for key project decisions, for establishing the criteria against which project success will be measured and for communicating the status of a project at any given point in time. However, cost estimating on infrastructure projects is inherently difficult given the high degree of uncertainty on schemes that can run for a number of years. Our review has highlighted evidence of cost increases/decreases on some of the projects considered which is likely to be the result of a number of factors, including:

- Inadequate contingency allowance
- Inadequate number of stage estimates
- Lack of allowance for inflation

3.2.5.1 Stage estimates

Following a review of the cost estimates made at various stages of the projects lifecycle it is our view that those made at the earliest stages i.e. the initial estimates were not sufficiently detailed. Broadly speaking they followed a relatively high-level project appraisal approach and seemed to be short of detail. Furthermore, cost estimates appear to be made at relatively few project stages. Ideally, cost estimates should be made at the following 11 project stages:

1. feasibility study
2. funding agency appraisal report
3. decision-to-proceed/commitment from funding agency
4. outline design
5. detailed design/issue of tender documents
6. receipt of bids
7. receipt of all critical permits and approvals
8. signing of contract with winning contractor
9. during construction
10. at the time of project opening for traffic
11. handover of completed works/final account settlement with contractor (return of Performance Security)

However, as a minimum we recommend that detailed cost estimates are produced at the following three project stages:

1. feasibility study

4. outline design

5. detailed design (detailed cost estimate based on BoQ)

with a subsequent calculation of the values of:

6. receipt of bids (tender value = contract price)

9. construction (contract price plus claims)

11. handover (contract price plus claims plus penalties/rewards)

In addition, it seems that the early stage cost estimates are often developed before there is sufficient design information for the estimates to be reliable. Where possible, early stage cost estimates should be based on more advanced preliminary design information. The consultants recommend that budgets are developed incrementally, stage by stage, until cost estimates are reasonably robust at project procurement stage.

The following recommendations should be adopted in the participating countries as soon as is practicable to improve the current cost estimating procedures.

- For early stage estimates we believe that it may be beneficial to provide cost estimates represented as a range between a realistic minimum and maximum rather than as a single point estimate. This approach could also be usefully applied to the time period over which the project lifecycle will take place or, at a minimum, the first of the three stages above.
- Systematically define the level of detail required for cost estimates at each (of the first three) stage of the project lifecycle listed above.
- Ensure that appropriate expert input is applied to each cost estimate.
- Agree with Funding agencies and adopt realistic forecasts of future cost inflation, based on an index designed specifically to reflect trends in infrastructure construction if available or alternatively one of the wider economic measures of inflation.

3.2.5.2 Contingencies

Our review highlighted inadequate contingency provision in infrastructure projects generally. We believe that the current lack of adequate contingencies allowances has contributed significantly to recent cost increases in the projects reviewed.

3.2.6 Conclusions

Our results suggest that cost estimates produced at appraisal are relatively inaccurate and the process for cost estimating during the early stages of the project cycle should be reviewed to ensure greater accuracy going forward. We have identified some process improvements that we believe if adopted by the participating countries would lead to more robust, rigorous and reliable cost estimates in the longer term. More specifically:

- The adoption of price adjustment mechanisms to respond to any price variation during construction for contract periods longer than 12 months;
- Further detail should be provided in early stage cost estimates (specifically feasibility stage) – including costs represented as a range (between a realistic minimum and maximum) rather than a single point estimate;
- Cost estimates should be produced at three project stages as a minimum;
- The inclusion of contingencies (both physical and price) in cost estimates produced at all stages of the project life-cycle.

More generally, our review suggests that there is room for improvement in the transparency of the cost estimation process in all of the countries studied. Furthermore, while there are standard national guidelines for cost estimating in most of the countries reviewed – the use of these is not mandatory in any of them. In our opinion any guidance should be mandatory to avoid inconsistencies in cost estimation practice.

In addition, it appears that since the early 1990s there has been a significant loss of general construction expertise (including cost estimating expertise) within many of the government departments in the countries studied. In our opinion it would be beneficial for the governments of these countries to employ some construction cost experts to enable or improve internal verification of cost estimates produced.

It is our view that once these changes have been implemented the cost estimation procedures in the countries reviewed will be considerably more robust, leading to more rigorous, consistent and reliable cost estimates in the longer term. However, we recognise that there are also likely to be significant levels of investment required by the countries concerned to achieve these changes, and it is likely that there will be some reluctance on the part of the individual countries to provide this investment. It is therefore likely to fall to the Funding Agencies to ensure that these recommendations are taken forward with some urgency and determination.

3.2.7 Summary

Standard Guidelines for cost estimation exist in seven of the nine countries covered[20] but adherence to these is mandatory in only one country/sector. Standard data sources for the production of cost estimates exist or are under development in eight of the sixteen country sectors. In virtually all cases cost estimates, usually based on defined or assumed sets of quantities and specifications of works are produced by external consultants which, in the absence of clear guidelines, reduces the consistency.

Construction costs are typically based on a combination of listed items with quantities and unit rates. Using a system of measurable units (cubic metres of concrete, kilometres of railway tunnel, etc.), the total project cost is calculated as the product of quantities and unit rates. This is conventionally called the 'base' project cost estimate.

Under best international practice, we would expect to see a series of agreed "gateways" through which each project would pass as the detail of design progresses. At each gateway the cost estimate would be developed in more detail. There is limited evidence of such process in the majority of the country/sectors.

There is clear evidence that, in about 75% of the country sectors, a contingency sum, to take account of unknowns, is added to the 'base' project cost estimate. Typically, the contingency value is a percentage of the total unit cost estimate or base cost and is often based solely on judgement or historical experience from similar projects. There is limited evidence that these contingency amounts are founded on a well developed risk register. Rarely, except on some very large projects, are the individual risks and opportunities quantified explicitly.

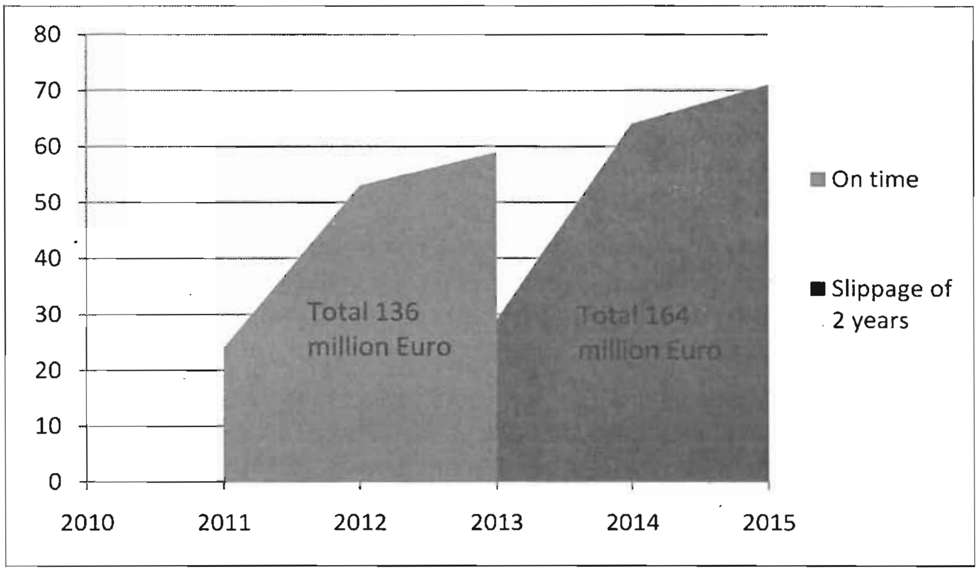
Independent verification of cost estimates (as they proceed through each design stage) occurs in about fifty per cent of the country/sectors.

From the sample estimates reviewed, it appears that one of the main reasons for cost overruns is likely to be the lack of adequate contingency allowances in early stage cost estimates. This is illustrated in Figure 3.1 which shows how the total cost of a project can increase as a result of slippage in schedule and higher than expected rates of inflation[21].

[20] All nine participating countries elected to participate in the review cost estimation methods. This review therefore covered the road sector in nine countries and the railway sector in seven countries (the rail sector EST and SI did not participate) making 16 country sectors in total.. These conclusions are set out in Table 3.2 of this report.

[21] In this example, implementation was delayed by two years and price contingencies allowed for inflation of 6% per annum, however actual inflation was 10%. The combined effect was to increase the total outturn cost from Euro 136 to Euro 164 million, an increase of 21%.

Figure 3.1: Example of effect of time slippage and higher than forecast inflation on project outturn costs



3.3 Task 5: Use of Price Adjustment Clauses

3.3.1 Objectives

The broad aim of Task 5 was to review the bill of quantity methodology and standard contract forms used on major road and rail infrastructure projects in the participating countries with a view to considering price adjustment mechanisms where appropriate. The specific objectives of Task 5 included:

- Review the current standard contract used in the participating countries (local contract form, FIDIC Red Book, FIDIC Yellow Book) and formulate standard Price Adjustment Clauses;
- Review the standard of bill of quantities used and formulate possible adjustment/modifications to facilitate easy implementation of the price adjustment clause;
- Write detailed instructions on the use of price adjustment and implementation thereof (when, how and for what it should be considered)
- Organise training on price adjustment application in contracts

The use of a price adjustment clause (PAC) within the overall procurement process provides the opportunity for contractors and Employers to share input inflation risk as, under contracts which allow a PAC to be included, contractors can be compensated for increased unit costs. Therefore, under PAC contracts, bid prices may be lower as certain risks do not have to be covered by the bidder.

3.3.2 Scope

The scope is the same as for Task 8 as described in section 3.2.2 above.

3.3.3 Methodology

3.3.3.1 Data collection

For completion of Task 5, we required access to specific examples of Bills of Quantities used in the participating countries and anecdotal evidence of "standard" contract forms used for major transport infrastructure projects, also whether the use of price adjustment clauses was accepted/standard practice.

3.3.3.2 Approach

To address the aims and objectives of Task 5, we undertook in-depth local engagement with project participants (specifically quantity surveyors and/or project managers) within the participating countries. To facilitate our approach, we developed an interview outline which we used to guide the interview process in each country and sector.

3.3.4 Results

3.3.4.1 Introduction

Variations in the price of construction materials and supplies such as asphalt, fuel, cement and steel can result in significant problems for contractors in preparing bids on long term projects. In some cases, prospective bidders cannot obtain firm price quotations from material suppliers for the duration of the project. This leads to price speculation and inflated bid prices to protect against possible price increases.

However, if price adjustment provisions are used in the contract to respond to price variations, a portion of the risk is transferred to the contracting agency, which can be expected to result in lower bids. Although it should be remembered that, since the contracting agency may have to increase the prices paid to the contractor, a reserve amount (in the form of a contingency allowance) must be set aside and included in the overall budget allocation for the project.

3.3.4.2 Summary of results

Following our individual country reviews, Table 3.3 below provides a summary of our observations regarding the bill of quantity methodology and price adjustment mechanisms adopted in each country by sector.

Table 3.3 : Contract forms and price adjustment mechanisms - summary

Country	Sector	Is there a standard contract form used for infrastructure projects?	Generally what form of contract is used for infrastructure projects?	Generally are priced BoQ used on infrastructure projects?	Are there any mechanisms employed to respond to any price volatility?	How is inflation dealt with during construction?	Are there robust construction indices available?
Slovakia	Rail	No	Local traditional	Yes	No	Risk passed to contractor	No
	Road	No	Local traditional	Yes	No	Risk passed to contractor	No
Poland	Rail	No	FIDIC	Yes	No	Risk passed to contractor	Yes
	Road	No	FIDIC	Yes	No	Risk passed to contractor	Yes
Romania	Rail	No - FIDIC was mandatory until recently	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	Yes - but not infrastructure specific
	Road	No - FIDIC was mandatory until recently	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	Yes - but not infrastructure specific
Latvia	Rail	No	FIDIC	No	No	Risk passed to contractor	No
	Road	No	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	Yes
Lithuania	Road	No	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	Yes
	Rail	Yes	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	No evidence
Estonia	Road	No	FIDIC	Yes	No	Risk passed to contractor	No
Czech Rep	Road	No	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	Yes - but not infrastructure specific
	Rail	No	FIDIC	Yes	No	Risk passed to contractor	Yes - but not infrastructure specific
Slovenia	Road	No	FIDIC	Yes	No	Risk passed to contractor	Yes
Bulgaria	Road	Yes	FIDIC	Yes	Yes	Construction indices used to adjust contract sum	No
Bulgaria	Rail	Yes	FIDIC	No	No	Risk passed to contractor	No

3.3.4.3 Forms of contract used on transport infrastructure projects

Generally, with some exceptions (notably Slovakia and Romania), the FIDIC Conditions of Contract (Red, Yellow or Pink Book) are used for both road and rail infrastructure projects in the participating countries, particularly if the projects are funded through the EU or one of the International Financial Institutions (IFIs).

3.3.4.4 Treatment of inflation

With the exceptions of Romania, Latvia [road], Lithuania , Czech Republic [road] and Bulgaria [road], there are no formal mechanisms for price adjustment on road and rail infrastructure projects in the participating countries. Contractors are therefore expected to price an inflation allowance into their bid, this approach can lead to inflated bid prices as contractors price high to compensate for any inflation risk.

3.3.4.5 Price adjustment clause

The price adjustment clause (PAC) method of adjusting contract cost is based on cost adjustment formula containing resource coefficients, representing the costs of labour, equipment and material resources as percentages of the total cost, combined with cost indices for each of those resources. The resource coefficients are set by the tenderer when completing the appropriate Appendix to Tender. It is also usual practice for the tenderer to define the source of the indices (normally linked to the currency of payment).

We believe that there is no direct link between a Bill of Quantities and a PAC as implied by the Terms of Reference for this study. A BoQ to be priced by bidders is an integral component of a contract using the FIDIC Red or Pink Book but a PAC can be included or not at the choice of the Employer (similarly with a FIDIC Yellow Book contract). In defining the resource coefficients, the tenderer does not draw directly on the data that they provide in pricing the BoQ (the tendered rates) but takes a contract-wide view of the relative costs of their primary inputs.

There is a fundamental difference between calculating price adjustment (up or down) on a range of actual costs and calculating price adjustment by formula methods. With actual costs, price adjustment is a net amount calculated from wages sheets, invoices and the like in accordance with the provisions of the contract. Price adjustment is applied only to those materials on an agreed basic list, and there is usually no specific provision for the adjustment of overhead and profit. Accordingly, we see no need to "formulate possible adjustment/modifications [to a BoQ] to facilitate easy implementation of the price adjustment clause.

However, formula price adjustment is calculated from the movement in index values irrespective of actual costs (or savings) incurred by the contractor. Individual rates included in the build-up of a tender are not used in the price adjustment calculation. There is a need, therefore, to specify the classes of materials subject to adjustment but no need to submit a list of the prices of all materials. There is no need to take account of or document future changes in wages and salaries because these fluctuations are accommodated by the application of an index covering labour costs.

It is important that users of formula methods of calculating price adjustment should appreciate that it does not purport to reflect with accuracy every minor change in construction costs or resource prices. It is a method designed to reasonably compensate the contractor for increases and reduce the delays and labour associated with traditional methods of adjusting payment.

Inclusion of a Price Adjustment Clause in the conditions of contract provides a method of sharing the risk of construction cost increases and thereby promote improved competition for infrastructure projects in the firm expectation of lower bid prices. Our individual country reports highlight the current international practice for price adjustment and set out a detailed plan for the incorporation of price adjustment provisions in international and local contract forms used in infrastructure tender documents in the participating countries.

3.3.5 Recommendations

However, if price adjustment provisions were to be used in the contract to respond to price variations, a portion of the risk would be transferred to the contracting agency, thus resulting in lower bids.

We therefore recommend, in the countries studied, all contracts procured using the FIDIC Conditions of Contract adopt Clause 13.8 for price adjustment where the contract period is greater than 12 months.

Furthermore, we recommend that where local forms of contract are used on contracts over 12 months in duration and which do not already contain recognised provisions for price adjustment, the FIDIC methodology should be adopted. However, where this is not feasible because the applicable indices and the resource coefficients have not been defined within the contract, a simplified price adjustment clause, for use within ongoing and future local contract forms, is provided in the individual country reports.

3.4 Task 10: Risk Management

3.4.1 Introduction

Risk management practice, at all project lifecycle phases, has been reviewed. Data have been collected from both rail and road beneficiaries, as well as selected government ministries. Reviews have concentrated on the four key risk management elements, namely risk identification, risk assessment (including risk analysis), risk response planning and risk monitoring.

3.4.2 Risk Management Guidance

About half of the participating countries have their own dedicated risk management procedures[22]. In Romania, NCMNR's new specialist risk unit *Management of Irregularities, Risk and Audit* has recently drafted its *Risk Management Guidebook – Clarification Note & Procedural Clarifications* for application from end 2009. This contains a recognisable risk management process and guidance on the principal risk management elements. Guidance on risk assessment, however, could be clarified, so that the reader knows what the key risk measures (e.g. cost, schedule) are.

Design consultancies, employed by the beneficiaries, use their own methods of risk assessment when developing preliminary and technical designs. Although we have not had sight of their procedures, selected outputs (e.g. risk registers) have been received and generally accord with good practice. It would be beneficial for beneficiaries to get a better understanding of their consultants' risk management procedures.

The EC's *Guide to Cost-Benefit Analysis of Investment Projects* provides guidance on the treatment of risk at appraisal and some countries (SK, BUL) have taken this template to develop their own appraisal handbooks. It is unfortunate that some stakeholders seem to view these methodologies as a necessary procedures to obtain scheme approvals (domestic or from the EC) rather than as valuable tools which can contribute to project sizing and definition according to sound economic principles which will deliver good value for money.

3.4.3 Risk Management Planning

Risk management planning is the systematic process of deciding how to approach, plan and execute risk management activities throughout the life of a project.

As with many of the other risk management elements, risk management planning may be being considered but there is little or no documented evidence. Even Romania's NCMNR *Guidebook* is silent on risk management planning, although the need for it is mentioned in the introduction.

[22] These are Latvia's Procedure Nr 14which provides insufficient guidance for the risk practitioner, Romania's Risk Management Guidebook – Clarification Note and Procedural Clarifications, Bulgaria's *Instruction for Assessment and Management of Risk* and Estonia's new quality assurance plan.

3.4.4 Risk Identification
The quality of risk identification is varied. Risk perception by many beneficiaries is based primarily on experience of comparable historical projects. This can provide a reliable means of risk identification but only if the list of risks is comprehensive and the data are representative and recorded. The Czech Republic's road administration, RSDCR, has a 'catalogue' of historical risks and associated mitigation measures, which it updates every two years.

Such a technique, however, needs to be complemented by other risk identification methods in order to arrive at a comprehensive list of risks. Good examples have been received from the Romanian roads administration NCMNR's *Risk Management Guidebook (Attachment 5)* and the Vilnius Western By-Pass in Lithuania

3.4.5 Qualitative Risk Assessment
A preliminary, qualitative assessment of risk exposure highlights the more significant risks. It, therefore, prioritises risks and effort for more detailed quantitative risk analysis and risk response planning.

Some risk classification schemes for judging risk probability and impact values have been identified (e.g. LAT and ROM). They are qualitative in nature and can be used to rate identified risks. What is missing is a clear linkage between the classification scheme and those risk measures (especially cost) that are important to the beneficiary. If a classification scheme includes methods for assessing individual risk measures, it forces risk consequences to be described more clearly in terms of impact on the relevant risk measures. This, in turn, will make the process of responding to and quantifying identified risks easier, more effective and more efficient.

3.4.6 Quantitative Risk Assessment

3.4.6.1 Overview
Cost risk quantification can help quantify a project's likely outturn cost and consequently inform monetary contingencies. It can also be used to review outstanding contingent reserves[23] post award of contract. This exercise can also contribute to the ongoing refinement of the scoping, costing, scheduling and procurement/delivery elements.

3.4.6.2 Observed QRA practice
Percentage uplifts to base cost estimates are typically used to determine cost contingencies at each lifecycle stage. These uplifts may well be informed by a beneficiary's perception of project risks but are often fixed or capped. They do not appear to be based on comprehensive risk assessments that can be scrutinised or audited. There are two potential adverse consequences: the first is that a percentage uplift is applied unnecessarily, thereby making the project prohibitively expensive; the second is that the outturn cost is underestimated and the beneficiary/ state treasury has to fund the shortfall once EC grant funds are exhausted.

The roads agency in one country (CZ – RSDCR), has reported that project costs at outturn very rarely exceed the estimate at appraisal. This country sector follows a process by which historical unit price data are recorded and used to inform cost estimates. This process may be one of the main reasons for this good performance. Importantly, all tendered prices, not just those submitted by the successful bidder, are used to populate Ministry of Transport (MoT) databases with average prices for each item. Prices, therefore, are market-tested and reflective of prevailing market conditions. This process is similar to Task 9 of this Study, which has involved collecting historical cost data from all participating countries for three points in a project's lifecycle, namely, appraisal, contract award and completion. The output is a series of uplift percentages to be applied from project appraisal to contract award as shown in section 2.3 of this report.

Quantitative risk analysis (QRA), using Monte Carlo simulation, is not commonplace, the only examples being observed in three countries (EST, LITH and CZ). In all cases these appeared to

[23] By "outstanding contingent reserves" we mean assessments of monetary contingency as the implementation phase develops and either money is drawn down from the contingent fund or the timeframes where an impact may occur pass without risks occurring.

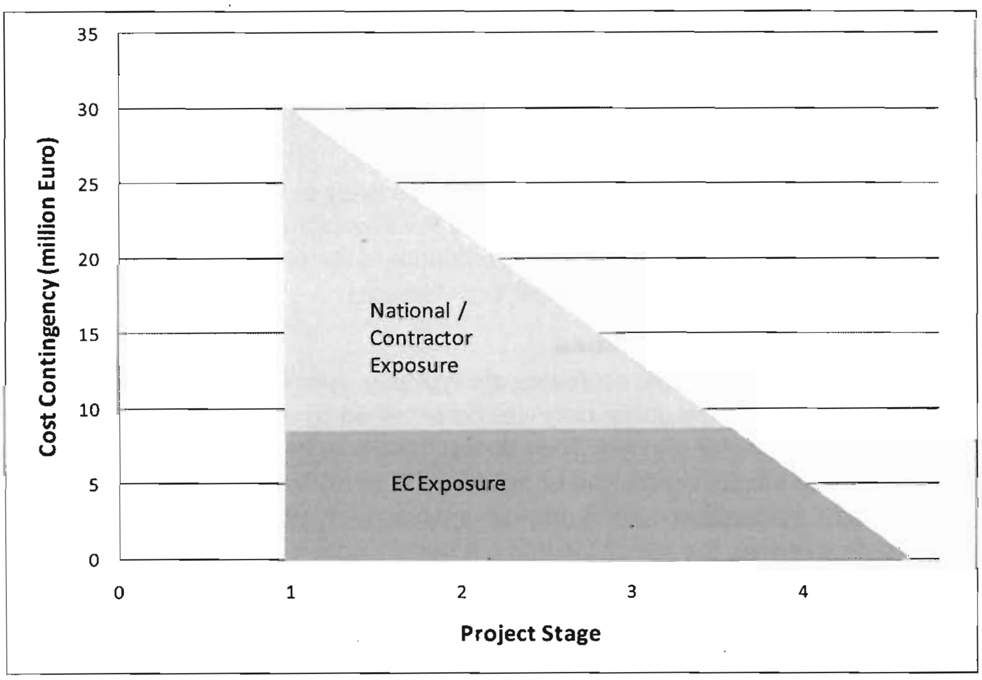
be used to support EU funding applications rather than official methodologies used on all projects. Unfortunately, the example from one country (EST) only modelled two risks, one threat and one opportunity. The reliability of the output results in informing a reliable cost contingency was, therefore, questionable. Another example (CZ) also modelled only two risks. The third example (LITH) modelled nine risks which had been identified as critical.

3.4.6.3 Consequences of contingency cap of 10%

As noted above, the allowable contingency amount at Application stage is capped at 10%. This means that, in the case of an imaginary project with capital cost excluding contingency of Euro 100 million, the maximum allowable contingency would be Euro 10 million. Assuming a Funding Gap Rate 100% and co-financing rate 85%, this contingency would enable the Managing authority (MA) to obtain an additional Euro 8.5 million in the Community Contribution[24].

Figure 3.2 takes this example forward for this hypothetical project where it is assumed that the real required contingency decreases over time from Euro 30 to Euro 5 million as the project progresses through four stages of design. This figure is intended to illustrate a point, perhaps well known, that the capped contingency should incentivize the MA to submit the Application when the design is relatively well developed (at stage 3 in this example) since, at earlier stages, it is the National authorities (rather than the EC) who are exposed to funding additional expenses which could arise from greater uncertainty in the costs of constructing a less advanced design.

Figure 3.2: National and EC Exposure to project cost contingency across four design stages for a €100m project.



The exposure of National authorities to cost overruns may be offset if construction contracts pass on some elements of cost risk to the contractor. This might be expected however to lead to higher bids on account of onerous conditions of contract. Indeed, there may be expected to be a trade off between certainty of outturn cost {from the National authorities' viewpoint] {more risks passed on} and the level of the contract price.

The intended contract type is less likely to be known at the time of the earlier stages of design. Also, there is not normally an allowance for cost certainty reflected in the spread of capital cost assumed in the QRA at project appraisal Further comments on choice of contract type are given in section 4.2 below.

[24] The arithmetic would be according to Table H2.1 of the application form.

3.4.7 Risk Response Planning

3.4.7.1 Introduction

There is little evidence of systematic risk response planning across the participating countries. A project risk register needs to include detailed risk response planning information at all project lifecycle phases. By so doing, it demonstrates that the beneficiary understands what the key risks are and has planned to ensure its related exposure is kept within tolerable limits

3.4.7.2 Contractual Risk Transfer

Alternative procurement structures (especially design-and-build, design-bid-build) are used by beneficiaries in an attempt to optimise risk transfer. Common risks (e.g. inflation and exchange rate fluctuations, contractor default) are allocated under terms and conditions of contract. However, without a comprehensive list of project risks it is difficult to justify selection of a particular procurement or delivery structure as providing optimal risk transfer.

Contractual clauses tend to be standard FIDIC Red Book and Yellow Book. The Czech Republic's RSDCR, however, does adjust its contractual clauses to account for experience of comparable historical projects.

The allocation of contingent reserves, as a risk acceptance strategy, is discussed in section 4.4.4 below.

3.4.7.3 Use of Price Adjustment Clauses (PACs)

Background

There are two issues in the use of price adjustment clauses:

1. Is price adjustment adequately covered (price contingency);
2. Is the allocation of price inflation risk properly managed/distributed between the Client and the contractor?

Annual consumer price inflation has averaged between 3 and 5% in seven of the nine countries with two showing higher rates (LAT 7% and ROM 12%). The analysis in Chapter 2 shows that in five (EST, LITH, LAT, ROM, BUL) of the nine countries construction price inflation is significantly higher than consumer price inflation.

Variations in the price of construction materials and supplies such as asphalt, fuel, cement and steel can result in significant problems for contractors in preparing bids on long term projects. In some cases, prospective bidders cannot obtain firm price quotations from material suppliers for the duration of the project. This leads to price speculation and inflated bid prices to protect against possible price increases.

Objectives of introducing PACs

Price Adjustment Clauses do not aim to reflect with accuracy every minor change in construction costs or resource prices. PAC is a method designed to reasonably compensate the contractor for increases and reduce the delays and labour associated with traditional methods of adjusting payment.

Inclusion of a Price Adjustment Clause in the conditions of contract provides a method of sharing the risk of construction cost increases and thereby promote improved competition for infrastructure projects in the firm expectation of lower bid prices.

Contract types

The results of our country reviews suggest that FIDIC forms of contract are used in the majority of countries/sectors. Priced bills of quantities form the basis of tenders in 14 of the 16 country/sector cases considered. In about 50% of cases, Price Adjustment Clauses are included in contracts whereas, in the remaining 50% materials and labour cost risks are passed on to contractors. The use of Price Adjustment Clauses should encourage lower priced bids[25].

In six of the eight countries/sectors where PACs based on cost indices are employed, robust construction cost indices are available but generally these do not provide costs specific to infrastructure. Development of such infrastructure-specific indices would be desirable.

3.4.8 Risk Monitoring and Control

Our review of practice indicates that the maintenance of a project risk register is not a requirement in most countries. Design consultancies maintain their own risk registers but are not required to submit them to clients for review. Beneficiaries are, therefore, not only failing to retain auditable records to help manage risks effectively on current projects, they are missing an opportunity to learn lessons to benefit future projects/programmes.

3.4.9 Programme Risk Management (PRM)

Beneficiaries can reap benefits by managing their projects in a coordinated manner. By clarifying a programme's success criteria and related requirements, programme management teams can ensure:

- Contractors are suitably prepared on award of contract;
- Consistent application of PRM best practice by suppliers;
- Reliable and timely indication of programme risk exposure (cost and schedule);
- Prioritised expenditure on risk response planning;
- Reduced chance of incurring financial losses (e.g. from delays and scope changes).

There has been little evidence of documented risk management at programme level[26].

3.5 Value Engineering

3.5.1 Introduction

Value Engineering (VE) is a structured and disciplined, team-centred problem solving technique to ensure the optimum balance between performance, cost and time.

In Europe, Value Management (VM) usually refers to work on the early stages of concept definition and strategy development. VE usually refers to the stages of design development and construction. Potential Savings are at their greatest early in the life of the project. The cost of change is lowest at this early stage.

3.5.2 Current VE practice across the nine participating countries

Of the nine participating countries, only four (BUL, ROM, LAT, LITH) elected to participate in the VE module of the Study.

The status of VE in the participating countries can be summarised as follows.

- In Estonia, there is limited knowledge of value engineering and it is not applied to any major road projects;
- In Romania. There is limited knowledge of value engineering but there is interest in improving the implementation of VE tools and techniques across major road and rail projects;
- In Latvia value engineering is not being applied to major road and rail projects but there is a keen interest to introduce it where applicable;
- In Lithuania there is limited knowledge of value engineering and it has not been applied to major road and rail projects. However, there is interest to introduce it where applicable.

[25] However, a reserve amount to cover price adjustment should be set aside and included in the overall budget allocation for the project.
[26] It is possible that beneficiaries select projects for inclusion in operational programmes based on some understanding of the aggregated risk exposure.

3.5.3 VE in Contractual Context

Clause 13.2 of the Red Book (and the Pink Book is identical) is headed "Value Engineering" and sets out the procedure (including payment) if the Contractor introduces a proposal to accelerate, reduce cost, improve efficiency or the product. In these circumstances, the "workshop phase" of the VE process would be much truncated as there would only be two stakeholders ---- the Contractor and the Engineer advising the Employer. The first two sub-clauses of 13.2 in the Yellow Book are identical with the equivalent text in the RB and PB but there is nothing about the fee to be paid to the Contractor: as YB contracts are fixed price (although cl. 13.8, if not deleted, can provide for price adjustment, of course), the Contractor may capture all cost savings from VE.

3.5.4 Conclusions and Recommendations

VE can be used for problem solving and relationship building through a well organised and managed process. If used early on in the project lifecycle, beneficial changes may be identified and implemented.

If it is used early enough in the project lifecycle then it can be considered a luxury that yields financial returns that outweigh the initial cost. If it is used late on in the project lifecycle, then VE becomes a priority that yields financial return on potential project over spends.

3.6 Budgeting Process

3.6.1.1 Overview: Transport Sector Budgeting Procedures

Three (LITH, CZ, ROM) of the four countries participating in the task on budgeting procedures responded to a questionnaire on budgeting processes. The results are set out in the following subsections.

3.6.1.2 Planning of the State Budget

In all three countries the State budget shows firm figures for the current year and indicative figures for the following two years. In two of the countries the replies suggest that, usually, not all the budget is spent (in one case 85%-90% is mentioned) and the shortfall can be carried over to the next year. In one country (ROM) this process is not automatic.

3.6.1.3 Response to cost overruns and underruns

The questionnaire sought to establish what happens to savings (when projects are delivered under budget) and shortfalls (when costs overrun). The replies indicated no evidence of explicit reserve funds or “magic” solutions to these outcomes. Contingencies (limited to a maximum of 10% in one country and stated to range between 5% and 10% of total project cost in another) provide the first port-of-call in the case of overruns. If these amounts are insufficient: “State investor has to find savings (real or just technical, like time delays) on other projects and apply for change of the budget”.

3.6.1.4 Treatment of Contingencies

Contingencies are included in the State budget in three countries. Price adjustments are included as a separate item in one country.

3.6.1.5 Project Selection Criteria

This question sought to establish the stage of the project cycle or the level of design required for a major project to be eligible for inclusion in the State budget. The answers varied as follows:

- “Government approval - - in the form of a Government Decision approving technical-economical indicators....based on positive opinion which assesses the Feasibility study + Technical Project (if Red FIDIC) + environmental Permit and other permits “ (ROM);
- “Project formulation and preliminary design conditions have to be met” (LITH);

In CZ, projects occur over a lengthy life cycle covering preparation and appraisal, land acquisition, preliminary and detailed design, tender, construction and finalisation after opening. These activities can extend up to a 15-20 year period.

3.6.1.6 Status of projects for which Applications Forms submitted

The responses to this question varied. One country (CZ) usually submits projects once they are under construction. CZ SFDI submitted a list of five rail and four road projects submitted once under construction, in 2008-2009. One country (LITH) submits applications when projects are at detailed design or at contract award. The third respondent (ROM) indicated a more wide ranging approach with one project submitted at preliminary design, three at detailed design and three once under construction in 2008-2009. This response indicated that projects have to be "sufficiently mature", with a feasibility study approved and environmental permits obtained.

4 Conclusions and Recommendations

4.1 Conclusions on Current Practice

The participating countries differ in their performance and practice. The central and northern countries appear more advanced in terms of competition for work and programme management – although real construction cost inflation is apparent in five (BUL, EST, LAT, LITH, ROM) of the nine countries and is not related to geography. Cost estimation processes vary in quality and can be said to be weak, by west European standards, in several countries. Risk management could be strengthened in all countries. The rail sector is more closed than the road sector in most cases, making data gathering and interrogation more difficult. This is an issue throughout Europe and not only in the participating countries.

The empirical evidence reflects this complex picture. Cost development is slightly easier to analyse as the need for "standard" projects is less critical. The results, from the roads database of just over 100 projects, show a wide range with under-runs and over-runs almost balanced. The rather volatile macro-economic situation may be partly responsible for these results, as contract prices and outturn costs may have been lower than estimated *ex ante* due to shortages of work – that is, cost estimates have appeared accurate and close to the outturn cost, but due to external market factors which by chance, have worked to modify any tendencies towards cost escalation and not as a result of the quality of the cost estimation. Importantly, this has not been the case in all countries, and in some instances there have been significant problems throughout the planning, appraisal and procurement processes leading to a cycle of repeated design and re-tendering resulting in very poor value and slow progress in implementation. It should be noted that this is the first time such an analysis has been done, and is unprecedented in the literature.

The results of the benchmarking exercises have revealed wide ranges in unit costs, most probably reflecting different country circumstances and changes in real costs over the evaluation period. A much stronger database would be needed to resolve these apparent wide differences and provide robust evidence for reliable benchmark unit costs.

Against this background, the recommendations from the Study can be divided into different groups which, in our view should be pursued (to varying degrees in each country) in parallel. The first group of recommendations is founded on our view that this has been a *useful* data collection exercise. The database should be handed over, lessons learned, and steps taken to expand the data, so that the conclusions on cost development and benchmarking can become more meaningful. We would imagine that it is a requirement that outturn costs of projects funded under the Operational Programmes are monitored and reported but we would recommend that, using the methodology of the present Study as a basis, this process should be formalised and a unit (within the EC or EIB) tasked with collecting and analyzing this information. There will be some transaction costs attached to this activity but, in our view, a concerted attempt should be made along these lines.

The second group of recommendations concerns measure to improve practice. These relate principally to cost estimation and risk management and are set out in the two sections that follow.

4.2 Cost Estimation

4.2.1 Cost Estimation Methodology

The conclusions from the review of cost estimation methods (3.2 above) indicate that, whilst Standard Guidelines for cost estimation exist in most of the participating countries, individual risks are seldom quantified and, in some cases, there is limited evidence that costs are reviewed as more information becomes known. To varying degrees across the countries and sectors, there is widespread use of external consultants and a lack of independent cost estimate verification. These practices lead to inconsistent and inaccurate estimates (the results in Chapter 2 suggest overruns in about 50% of all cases) producing complications as projects move from planning into implementation.

It is our view that cost estimates are not fixed figures and should be subject to continual review as project objectives, constraints or risks change.

We recommend that there should be a structured cost estimating process. There should be an entity designated as responsible for this process. The process itself should, inter alia, be based on clear guidelines, recognise defined stages in the project cycle, employ a defined methodology drawing on an accepted historic data base, include agreed methods for incorporating physical and price contingencies and, for larger projects, a procedure for independent verification. This could take the form of Value Engineering.

Cost planning should develop in detail as more design information becomes available. We recommend the adoption of cost planning gateways (or stages) such as those outlined in Table 4.1 below. As a minimum, we recommend that estimates are produced at feasibility study, outline design and detailed design (detailed cost estimate based on Bill of Quantities).

It is also recommended that the countries should review the process for cost estimating during the early stages of projects to ensure greater accuracy. Where possible, early stage cost estimates should be based on more advanced preliminary design information. In particular, the percentages added for contingencies at this stage may not be sufficient to compensate for the relatively "light" approach to cost estimation.

Table 4.1: Cost Estimation Gateways

	Work stages	Formal cost estimating & elemental cost planning stages	Gateways
Preparation	Appraisal	Order of cost estimate	Business justification
	Design brief		Delivery strategy
Design	Concept	Formal Cost Plan 1	Design brief & concept approval
	Design development	Formal Cost Plan 2	
	Technical design	Formal Cost Plan 3	Detailed design approval
Pre-construction	Production information	Pre-tender estimate	
	Tender documentation		
	Tender action	Post tender estimate	Investment decision
Construction	Mobilisation		
	Construction to practical completion		Readiness for service
Use	Post practical completion		Operations review & Benefits realisation

Source: Based on RICS New Rules of Measurement (UK, 2009)

Notes to Table 4.1:

1. Order of cost estimate – high level cost estimate based on project scoping and options analysis to support the business case
2. Formal Cost Plan1 – prepared when the scope of the work is fully defined and key criteria specified but no detailed design has taken place;
3. Formal Cost Plans 2&3 – progression of the first cost plan, these stages are developed through the measurement and checking of cost-significant elements as more design information becomes available;
4. Pre & Post tender estimates – detailed cost estimate to inform the tendering process.

We recommend that early stage cost estimates should include a base estimate with indication of a realistic range of cost about this base. The base estimate and the range should be refined as more information becomes available. Estimates should incorporate forecasts of cost inflation based on an index of construction costs or general price inflation if a price index for construction sector costs is not available. The range about the base estimate should take account of contingencies not accounted for in the base. Our recommended approach to estimation of contingencies is set out under Quantified Risk Assessment in section 4.2.2.

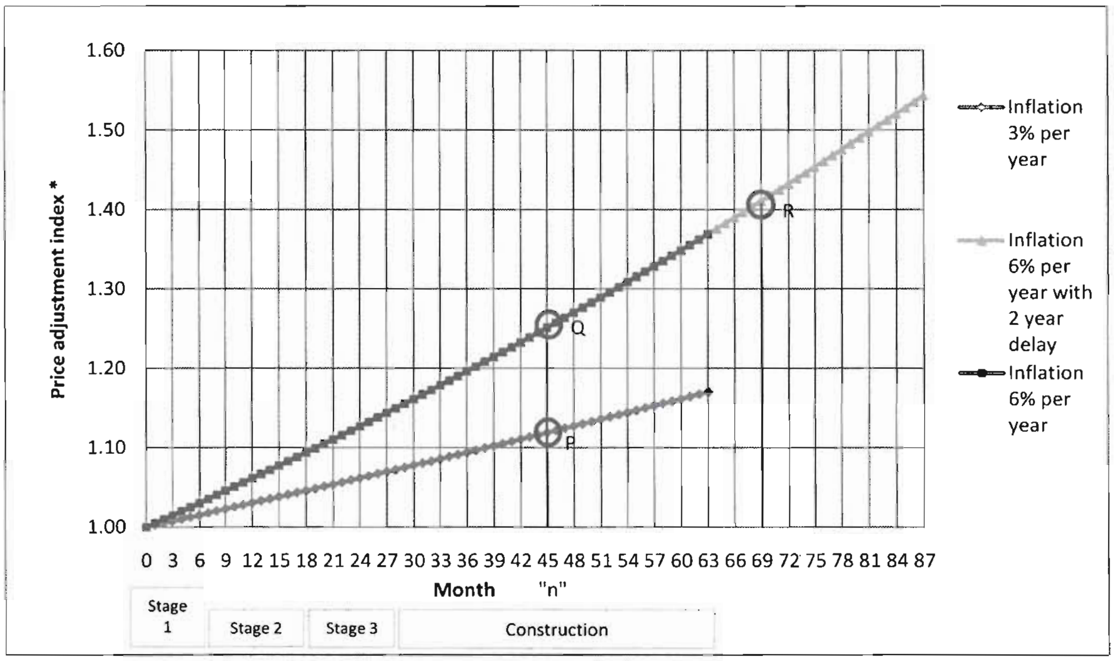
We recommend that Value Engineering (VE) should be carried out at the design and construction project development stages. There is currently limited practice of VE in the four countries (BUL, ROM, LAT and LITH) which participated in the VE module. Further guidance on VE techniques are provided in the VE Guidance report[27].

4.2.2 Allowances for Contingency and Price Adjustment

Section 2.3.6.2 discussed the sufficiency of funds allocated and the case for encouraging countries to include an allowance for price adjustment amounts given the contingency cap of 10% and uplift percentages required to cap the risk of a cost overrun to a given %.

The figure below illustrates how the price adjustment factor increases over time as a project progresses through the planning and design stages with annual average inflation at 3% and 6%.

Figure 4.1: Price adjustment factor over the project lifecycle



* Index shows Price Adjustment Factor for month "n" to be applied to 'Base' cost estimate made in month 0. An example is shown in Table 4.2. This shows the Price Adjustment Factors as indices applied to the mid point of the construction programme. Construction is assumed to begin in month 27 and continue over a three year period with an even spread of works over the three years. The mid point is therefore month 45. If a two year delay was to occur to the works then the mid point would be month 69.

Table 4.2: Price Adjustment Factors (PAF) for the mid point of construction

	PAF	Point
3% inflation	1.12	P
6% inflation	1.25	Q
6% inflation + Delay	1.41	R

At each stage of project development the PAF needs to be recalculated from the current base point. For example, in the chart above if inflation had been 6% per annum during Stage 1, in month 6 at the start of Stage 2 the base cost would now be 1.03 rather than the 1.00 from month 0. The ratio of the PAF at month 45 to the PAF at the current point would then need to be taken to calculate the PAF to be applied to the new base point. Therefore if inflation was forecast to

[27] Task 11: Value Engineering: Guidance on Value Engineering Techniques

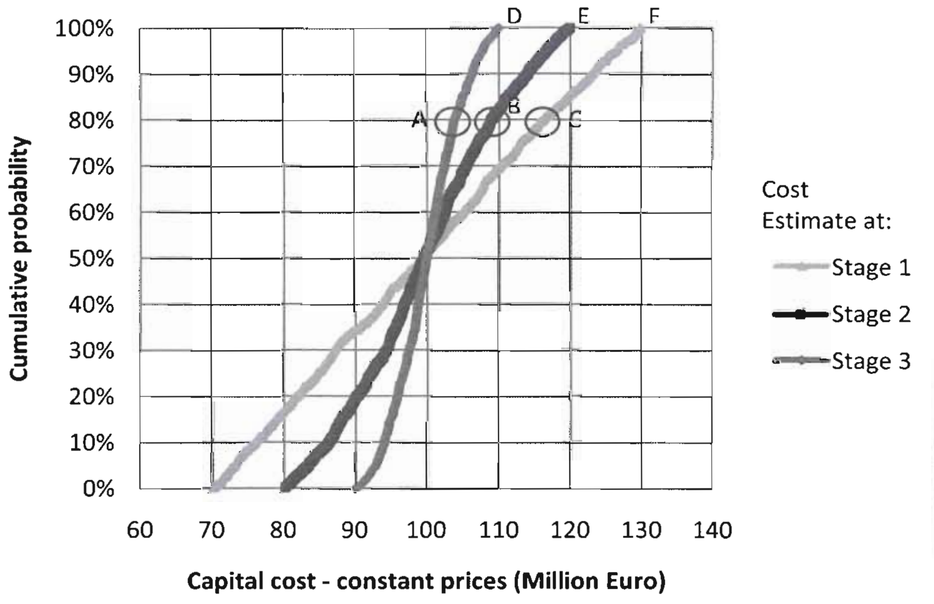
continue at 6% per year then the PAF at Stage 2 for the mid point of construction (month 45) would be 1.25/1.03 = 1.21

If inflation increases at a higher rate than forecast, project costs can increase rapidly. It is therefore important to ensure adequate allowance for price adjustment. Time delays will also impact on the project budget as inflation over the delay period increases costs further. This is shown in the figure above by the green line, where a two year delay to the start of construction occurs and results in a sharp increase in the price adjustment index required.

A high allowance for contingencies is needed in the early stages of project development when risks and uncertainty are high and the actual outturn costs could therefore be within a wide range. As the project progresses and uncertainty decreases, this range narrows and the level of contingency can be decreased. Figure 4.2 and Table 4.3 below set out an example illustrating the decreasing contingency factors.

These ranges are based on illustrative cost spreads reflecting decreasing uncertainty. These ranges together with further explanation of how they were derived are given in Appendix C. Two sets of values are shown for the contingency percentages – one with the objective of being 80% certain of no cost overrun and the other with the objective of being 100% certain of no cost overrun. The lower the beneficiary's appetite for risk, then the higher the contingency that is required.

Figure 4.2: Cumulative probability distribution for capital cost



Stage 1 - appraisal / application for funds
Stage 2 - outline design
Stage 3 - detailed design before tender

Table 4.3: Contingency allowances

	Stage		
	1	2	3
Required contingency - 80% certainty	16.1% Point C	8.8% Point B	3.8% Point A
Required contingency - 100% certainty	29.9% Point F	20.0% Point E	10.0% Point D

Further explanation about contingencies and price adjustment factors are given in Appendix C.

4.3 Risk Management

4.3.1 Risk Management Guidance

We have developed a Guideline of Best Risk Management Practice which has been disseminated at workshops. Knowledge of this *Guideline* will allow the beneficiaries to judge whether the procedures followed by their consultants are appropriate and, eventually, to develop procedures for their design consultants.

4.3.2 Risk Management Planning

Risk management planning is the systematic process of deciding how to approach, plan and execute risk management activities throughout the life of a project. The exercise should clarify:

- Risk management roles and responsibilities both within and outside the beneficiary's organisation;
- The level of cost risk exposure the beneficiary is prepared to tolerate;
- Risk management techniques and tools to be used;
- The scheduling of risk management activities in relation to the overall project plan.

Post contract award the risk management plan (RMP) should be updated following award of construction contract to:

- Undertake a survey of the signed contractual documentation to identify which risks have been transferred or retained;
- Document which risks have yet to be resolved as at contract execution;
- Consider potential residual risks;
- Understand risks associated with failing to manage the contract effectively;
- Consider possible changes to the contractual arrangements to manage identified risks more cost-effectively.

4.3.3 Risk Identification

There are many recognised risk identification techniques, including creative workshops, interviews (with discipline leaders) and reviews (of documentation and databases). In each case, it is important to elicit information from all key project stakeholders. Information can be gathered using:

- Risk prompts: These provide a set of categories of risk that are pertinent to the type of project under consideration or the type of risk being considered by an organisation. The lists are used to help people think about and identify risks. A project plan and a work breakdown structure, with all of the major tasks defined, are natural prompt lists. A prompt list will never be exhaustive, but acts as a focus of attention in the identification of risks.
- Checklists: These can be used in tandem with risk prompts. They are a series of questions to be asked based on experience of previous problems or opportune events.

4.3.4 Quantitative Risk Assessment (QRA)

4.3.4.1 Overview

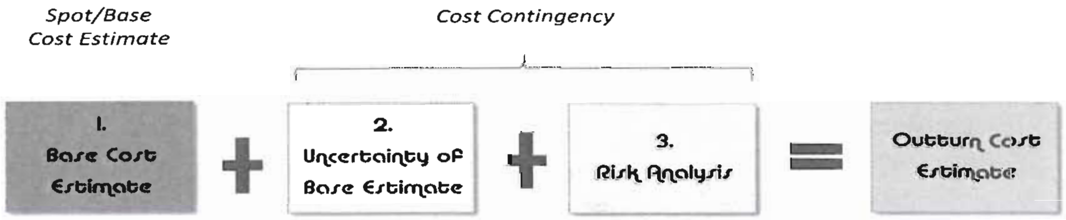
We recommend that QRA be formally adopted in the country sectors where it is not being used currently.

Cost risk quantification can help quantify a project's likely outturn cost and consequently inform monetary contingencies. It can also be used to review outstanding contingent reserves[28] post award of contract. This exercise can also contribute to the ongoing refinement of the scoping, costing, scheduling and procurement/delivery elements. The main features and rationale for the QRA process and a worked example are set out in Appendix C.

4.3.4.2 Estimation of Cost Contingencies

We recommend that cost contingencies are estimated using a QRA approach and added to base cost estimates developed using the approach set out according to the recommendations in section 4.1. The sum of the Base cost estimate and the estimated contingencies is the estimated outturn cost (see Figure 4.1). The cost contingencies in Box 2 reflect all the uncertainties in the rates and quantities of the items included in the base cost estimate whilst the cost contingencies in Box 3 reflect all other cost uncertainties arising from events which may or may not happen.

Figure 4.1: Composition of Outturn Cost Estimate



Good practice in the estimation of cost contingencies should incorporate the following principles:

- Using a risk register, all the potential unknown or uncertain factors which may influence outturn cost should be identified (see Table 4.4.2b of the Risk Management Guidelines)
- Probability distributions should be ascribed to each factor
- Correlations between factors must be assumed
- These distributions should be input to a risk assessment programme. The output will indicate, based on the input assumptions, the probability that outturn capital cost will exceed a given amount.
- Based on this result, the Managing Authority can , according to its appetite for risk, set a contingency amount which if established as a contingent reserve , would be sufficient to cover cost increase up to the selected amount

4.3.5 Risk Response Planning

4.3.5.1 Overview

Risk identification and assessment is a worthless exercise unless responses can be developed and implemented. Indeed, the effectiveness of responses directly determines whether risk exposure remains within tolerable limits.

4.3.5.2 Contractual Risk Transfer

A full treatment of the impact of contract type is beyond the scope of this study. There is a widespread perception that adopting the FIDIC Yellow Book (YB) conditions of contract, under which the construction Contractor produces the detail documents for construction in accordance with the Employer's Requirements and then carries out construction, gives greater opportunity to transfer risks to the Contractor than is possible under the Red Book (RB) conditions, under which

[28] By "outstanding contingent reserves" we mean assessments of monetary contingency as the implementation phase develops and either money is drawn down from the contingent fund or impact timeframes pass without risks occurring.

the Contractor constructs the works designed by the Employer. Additional attractions of adopting the YB conditions are seen to be savings in time (being able to proceed to tender without waiting for detailed design to be completed) and savings in money (not having to pay a design consultant to produce the detailed design).

Some of the attractions of using the YB conditions may be illusory: a tender may be launched sooner but the overall success of the project will to a large extent depend on the precision of the Employer's Requirements (which may be rushed) and the consultant working for the Employer on this task may not have sufficient (even "any") experience of this task. The cost of production of drawings and other construction documents is simply transferred to the construction contract (added by the Contractor to their tender price but not seen as a line item) and many Contractors are more experienced at building works than at designing them (the quality of the final works may go down or achieving quality become problematic). The procedures of construction may also be unfamiliar to all parties --- the "loop" of conceptual design>comment and approval>detailed design>comment and approval (possibly including the Employer) before the start of construction may offset time "saved" pre-tender and the construction supervision consultant may need substantial head-office support on technical issues, for instance, matters of structural design that are outside the competence of the site staff.

YB contracts are usually lump-sum (without a mechanism for price adjustment although the FIDIC template does permit that) with the Employer's objective being a more certain outturn cost than, historically, was achieved with the RB format but, during construction, there is a strong commercial pressure on the Contractor to find omissions in the Employer's Requirements and/or suggest scope changes thereby increasing the overall cost. For "works" that may involve rapidly changing technology and where the Contractor can innovate to the advantage of the Employer (such as railway signalling), the YB conditions are generally appropriate and, properly managed, are to the advantage of the Employer. However, for "low-tech" works, such a new road without exceptional features, use of the YB conditions may be precluded by the funding agency or grant donor until there is secure title to all the land needed for permanent construction.

4.3.5.3 Use of Price Adjustment Clauses

As shown by the example above, given typical rates of inflation, projects over 12 months' duration can experience significant unit-price-related cost overruns. We recommend in the countries studied, all contracts procured using the FIDIC Conditions of Contract adopt Clause 13.8 for price adjustment where the contract period is greater than 12 months.

4.3.6 Risk Monitoring and Control

It is critical that the risk management process monitors a project's risk profile and the actions taken to manage it, because risk exposure can change over time owing to the implementation of risk response measures, the emergence of new risks, the occurrence of risk events and the passing of risk impact timeframes.

Risk monitoring should occur throughout the life of a project. Recommendations for activities covering monitoring of current risks, identifying new risks, conducting periodic reviews and reassessing risk exposures are set out in section A4.7 of our Risk Management Guidelines.

4.3.7 Programme Risk Management

Programmes need to take account of risks at project, programme and strategic/national levels. Recommendations are set out in section A4.8 of our Risk Management Guidelines.

4.4 Budgeting process

The Study set out with the intention to apply a Reference Class Forecasting (RCF) approach to determine contingency allowances to be set aside, as part of the budgeting process, to fund cost overruns. The roads sector database developed is based on projects appraised mainly over the period 2000-2004 and completed over 2003-2009. The projects included were presented at varying levels of maturity at appraisal and in nine different countries.

In this context, two sets of factors limit the relevance of RCF as it seeks to derive factors from the analysis of one set of data which can be applied to budgeting for projects in the future. In the first instance, in most cases, the countries have experienced significant institutional change and process development over this period, so that cost estimation and appraisal methods employed now are more advanced than in the 2000-2004 period. Secondly, the nine year period covers an upturn (overheating) and downturn in the economic cycle making the pooling of data into a common base more problematic. For these two reasons, we consider it dangerous to infer too much from the results of the analysis to develop anything other than very broad cost development factors for application in the budgeting process.

However, the basic premise of RCF, that optimism bias can result in a systematic underreporting of the level of risk, remains sound and should be one of the starting points for the development of risk registers. Building on observed improvements in practice, we are recommending further actions to improve the quality of cost estimates, particularly in the area of risk management. The implementation of these actions should improve the quality of cost estimates and reduce further historically-based cost development factors.

Our concerns on the application of cost development factors, based on historic data, to inform the budgeting process, have been set out earlier. Importantly, there seems to be no clear link between the % contingencies included in appraisal and the setting aside of funds to these amounts to take care of such outcomes. Additionally, whilst countries with larger project portfolios may have more scope to move funds between projects, it will not always be possible to capture savings from under-runs for use on cost over-running projects. Thus, the average cost development factors estimated above may understate the actual need for funds and furthermore, especially in the current economic climate, it is not clear that these funds will be available. Whilst reasonable, as it incentivizes the host country to take responsibility for cost estimates, the imposition of a 10% contingency cap in the CF/ERDF Application Form may complicate this process as it may artificially limit the estimates of total project cost at appraisal.

These issues are likely to have more significant impacts on the budgeting process in countries or organisations with smaller portfolios of projects, where opportunities to transfer funds are less apparent. In these circumstances it may be appropriate to allow a higher budget reserve as there are fewer projects and, in any one year, the overrun across all their projects may not be as close to the expected average. Where the portfolio is small, there is a much greater potential for one project with a large overrun to influence significantly the average across all projects

Appendix A

List of Project Reports and Databases

A1 List of Project Reports and Databases

Reports

Inception Report

Data Collection Report

Cost Benchmarking Road Sector Report

Cost Development Road Sector Report

Cost Benchmarking and Development Rail Sector Report

Cost Benchmarking and Development Urban Transport Report

Formulating a standard price adjustment clause and review of Bill of Quantity Methodology and Review of cost estimating methodologies in participating countries and proposal of amendments to the methodologies: Overview Report

Risk Management Report

Value Engineering: Guidance on Value Engineering Techniques

Country Report (one report for each country)

CFPM Workshops Attendance and Feedback Report

Databases

Road Database – Current prices

Road Database – Constant prices

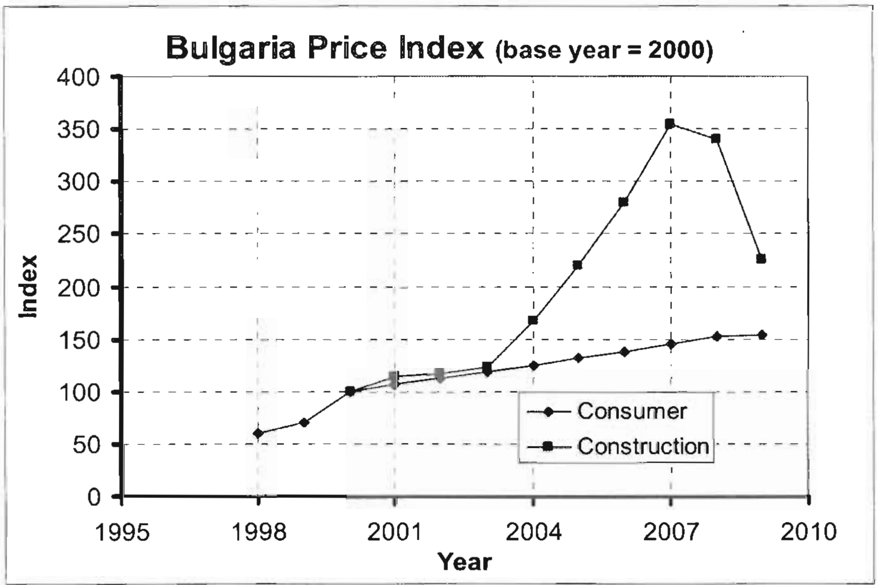
Rail Database

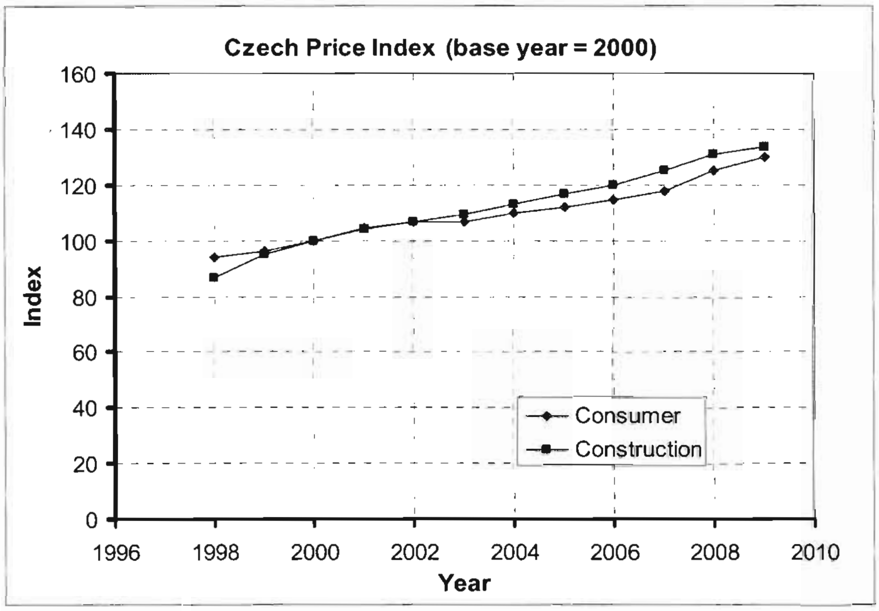
Urban Transport Database

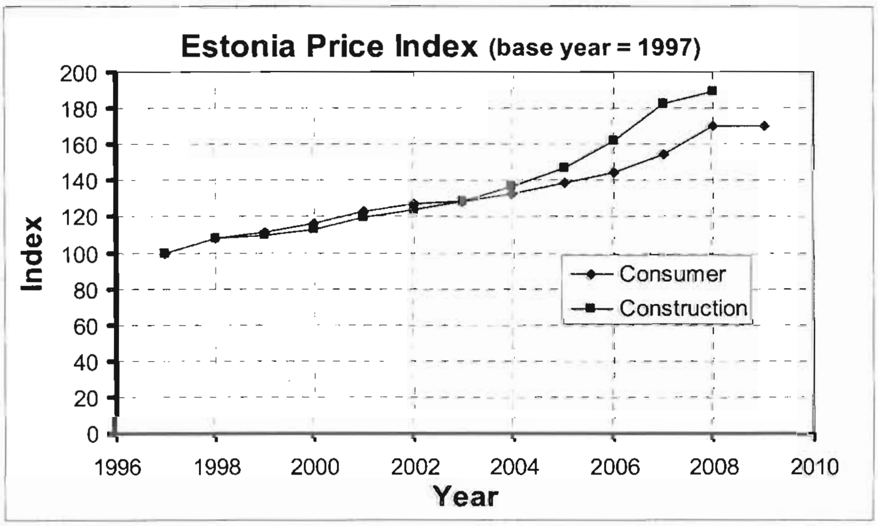
Appendix B

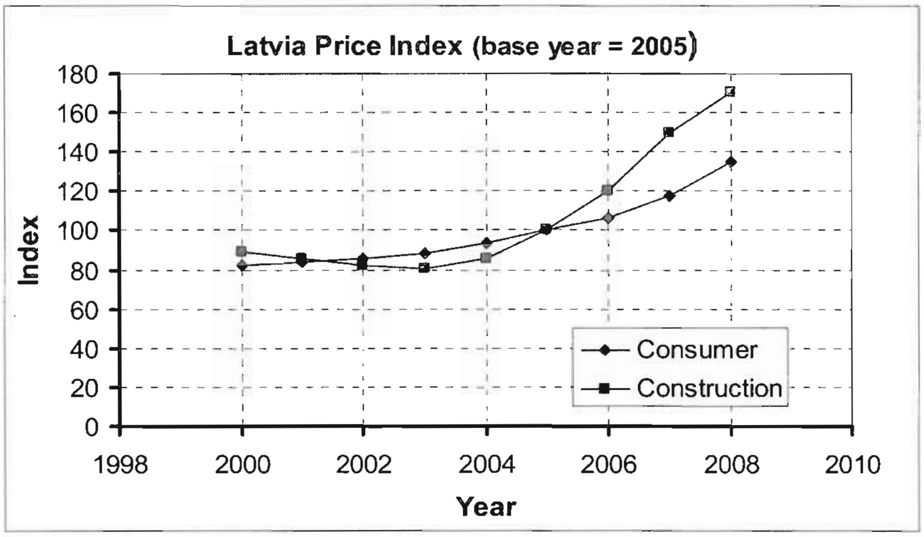
Consumer and Construction Price Indices

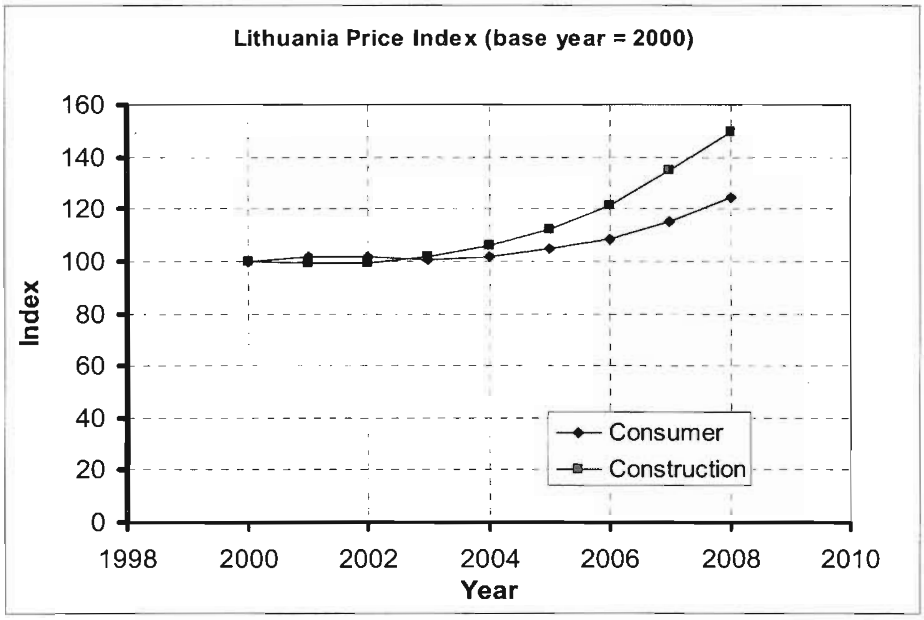
B1 Consumer and Construction Price Indices

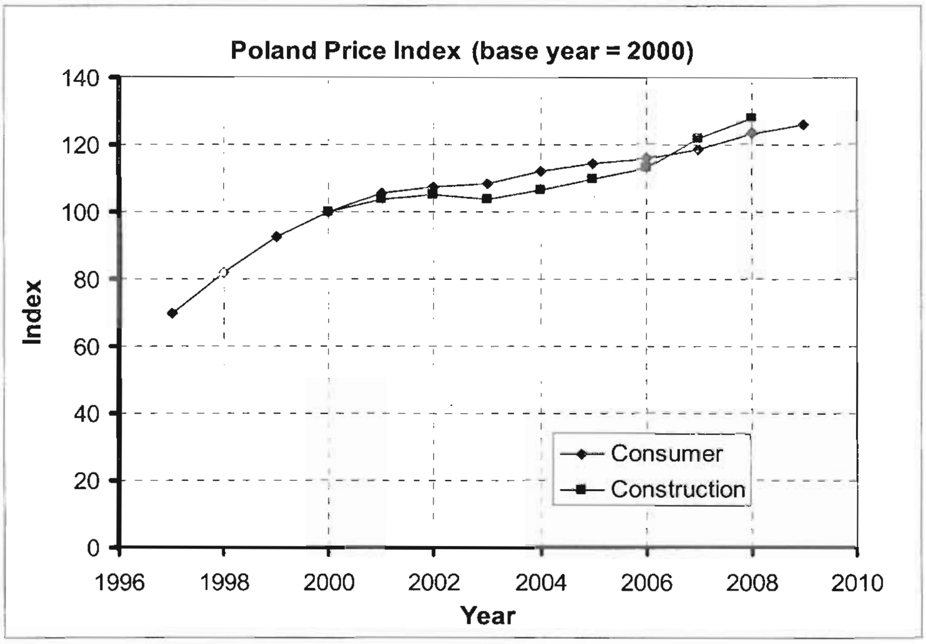


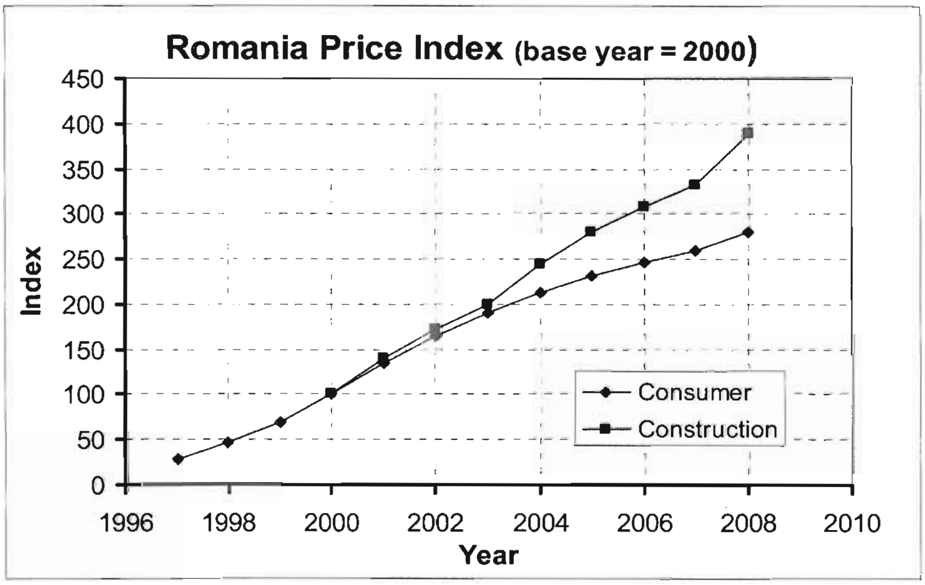


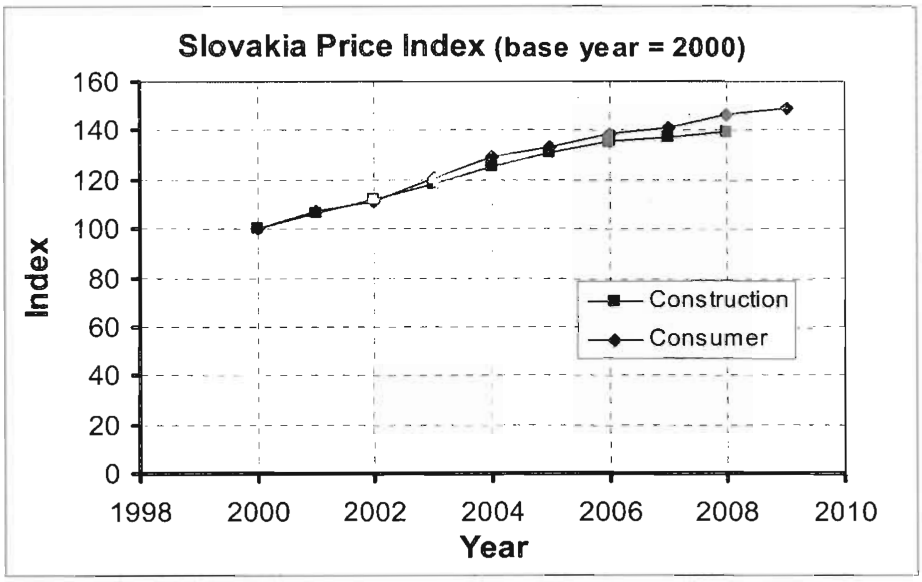


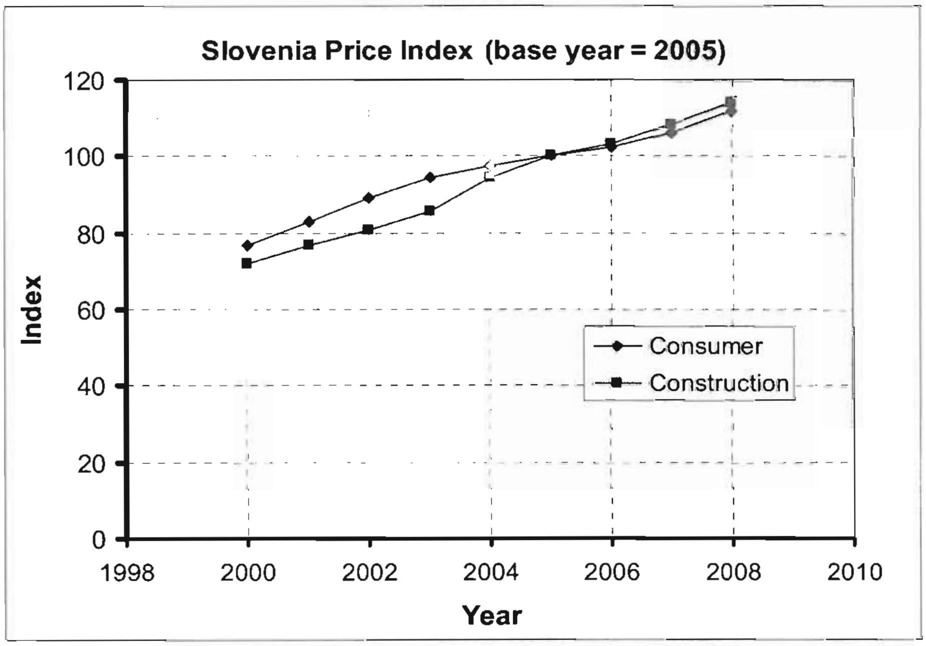

Latvia Price Index (base year = 2005)
Index
180
160
140
120
100
80
60
40
20
0
1998
2000
2002
2004
2006
2008
2010
Year
Consumer
Construction


Lithuania Price Index (base year = 2000)
Index
160
140
120
100
80
60
40
20
0
1998
2000
2002
2004
2006
2008
2010
Year
Consumer
Construction


Poland Price Index (base year = 2000)
Index
Year
Consumer
Construction
0
20
40
60
80
100
120
140
1996
1998
2000
2002
2004
2006
2008
2010


Romania Price Index (base year = 2000)
Index
Year
Consumer
Construction
0
50
100
150
200
250
300
350
400
450
1996
1998
2000
2002
2004
2006
2008
2010


Slovakia Price Index (base year = 2000)
Index
Year
160
140
120
100
80
60
40
20
0
1998
2000
2002
2004
2006
2008
2010
Construction
Consumer


Slovenia Price Index (base year = 2005)
Index
Year
120
100
80
60
40
20
0
1998
2000
2002
2004
2006
2008
2010
Consumer
Construction

Appendix C

Quantitative Risk Assessment and Contingencies

C1 Quantitative Risk Assessment (QRA) and Contingencies

The rationale for undertaking a Quantitative Risk Assessment (QRA) is as follows:

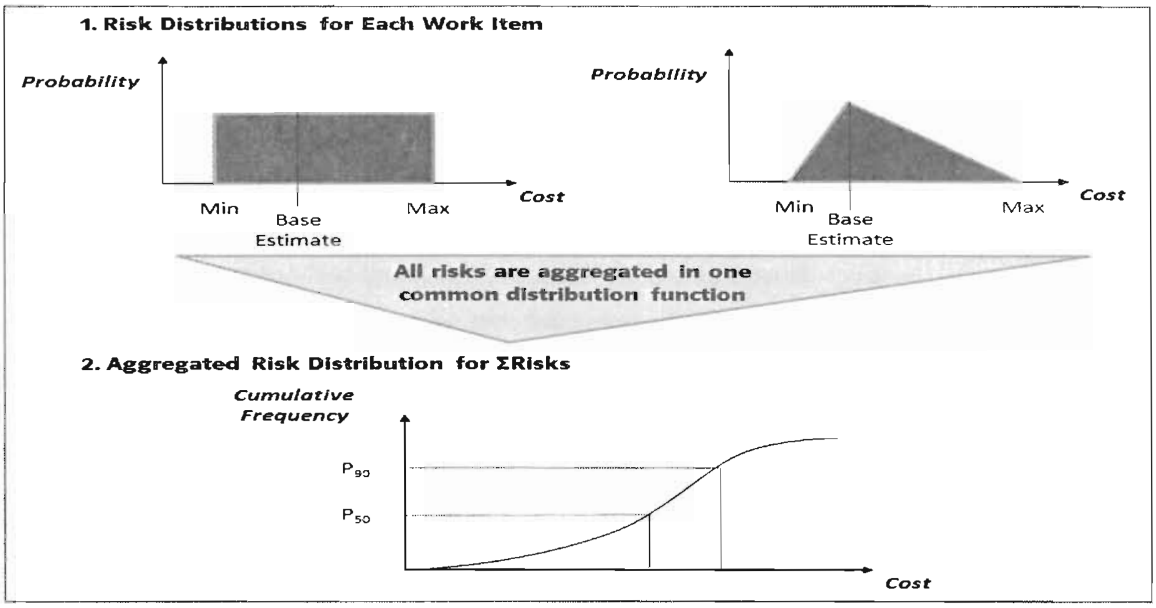
1. Accounts for all possible outcome of risk or uncertain item
2. Accounts for the probability of potential outcomes
3. Illustrates the levels of cost uncertainty or spread on projects
4. Illustrates the confidence in individual cost outcomes
5. Highlights the dominant cost risks
6. Provides for reliable monetary estimates of project contingencies and hence helps to inform project outturn costs
7. Illustrates residual cost risk exposure post contract award relative to budget/contract price

There are six steps to a QRA:

1. Judge the cost range for each risk or uncertainty
2. Model and analyse using a recognised risk analysis software program (e.g. @RISK, Crystal Ball);
3. Select an impact distribution (e.g. normal, PERT, triangular) that best fits the cost range;
4. If a risk (i.e. chance event) rather than an estimating uncertainty, describe the probability of the risk occurring using a Binomial probability distribution;
5. Account for the possible dependency between risks and uncertainties by using correlation coefficients;
6. Run sufficient iterations to ensure convergence (i.e. results stability/reliability)

Figure C1 below shows the risk distribution process, illustrating how the distributions for each individual risk are combined into an aggregated distribution for all risks, giving a cumulative frequency. This allows the cost for a given probability to be estimated. For instance, it is possible to determine the cost that would be required to be 90% certain that there would not be a cost overrun.

Figure C.1: Risk Distribution Process



An example of QRA, showing the application of a risk analysis to the capital cost of a scheme is given in the Box below.

Box: Application of QRA: showing variation in capital cost of scheme

The example below is for an imaginary project with a base cost estimate of 100 million Euro.

A Monte Carlo risk analysis has been carried out using @RISK for the capital cost. The inputs used were the risks identified as critical risks. A triangular distribution has been assumed for each of the variables using the minimum, most likely and maximum values shown in the table below:

Risk Description	Range Estimates[29]			Probability Distribution	Impact Distribution
	Minimum	Most Likely	Maximum		
Unforeseen ground conditions	€500,000	€2,500,000	€6,000,000	Binomial[30]	PERT[31]
Unanticipated labour short□ge	€1,000,000	€2,000□000	€3,000,000	Binomial	Normal[32]
Pavement ra□es and quantities estimating uncertainty	-15%	Spot esti□ate	+20%	N/A	Uniform[33]
Unexpected archaeological fin□ings	€10,000	€1,000,000[34]	€10,000,000[35]	Binomial	PERT

29 Accounts for direct costs only. Programme delay cost risks should be modelled differently since programme delays can occur in parallel. To model individual programme risks is therefore likely to overestimate cost risk exposure

30 Effectively switches a risk on or off. When switched on, a value is randomly selected from within the set range. The number of times a risk is switched on (or off) is governed by the probability of the risk's occurrence

31 PERT is a 3-point distribution, which place greater importance on the most likely value. In this case, it reflects our confidence in the most likely value

32 Best-fit distribution for symmetrical spread about the most likely value

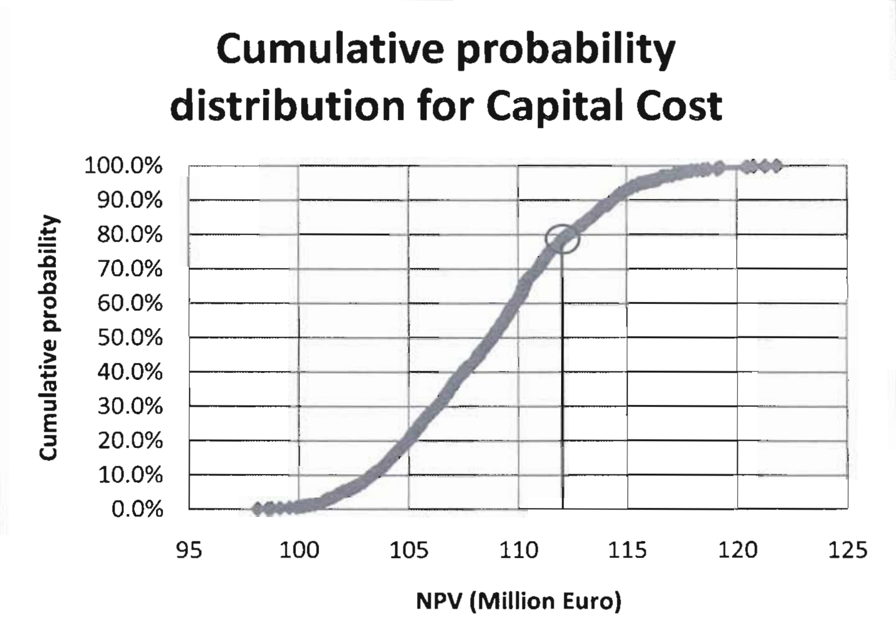
33 Assumes all potential outcomes (including spot estimate) are equally likely

34 Assumes cost of expert investigation

35 Assumes cost of alternative alignment

No correlation has been assumed between any of the risks. The simulation was run for 1000 iterations. The cost of delays to the programme was assumed to be 5 million Euro per year.

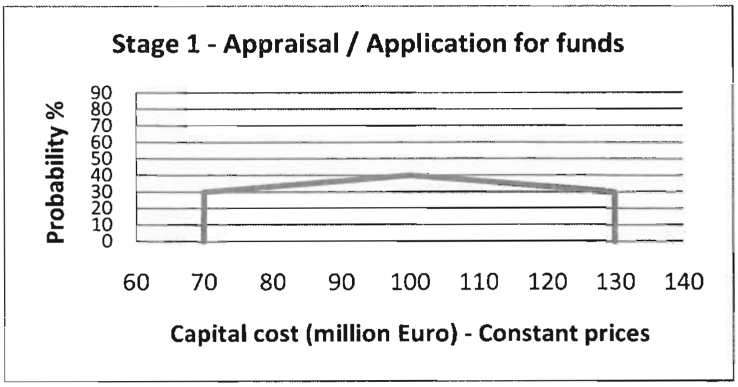
The cumulative probability distribution of the capital cost is shown below.



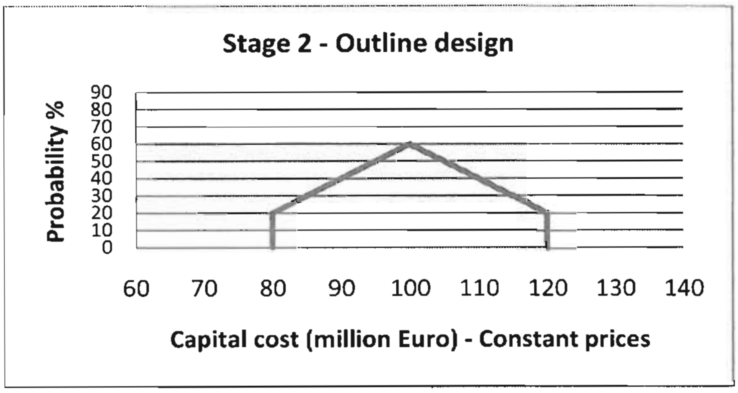
The probability that the outturn capital cost will be the Base estimate or lower is less than 1%. In order to be 80% certain that the outturn cost will not exceed the budget (including contingency), a contingency of 12 million Euro would be needed.

The above QRA process should be kept under regular review. The cost range should narrow as more information on the explanatory variables becomes available.

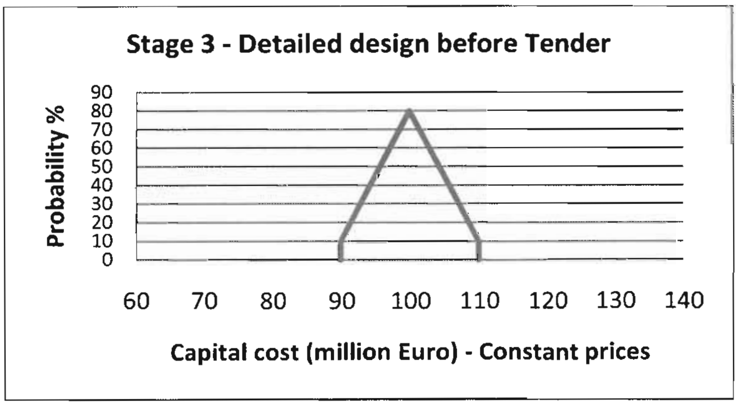
The figures below illustrate this narrowing of the cost range and how this can be related to the contingency required. They show the distribution of the possible values of the capital costs at different stages in the project development for a theoretical project with a base capital cost estimate of 100 million Euro. The first figure shows the costs at the stage of appraisal or the application for funds. At this stage the range of the cost is wide as there are still many uncertainties and the project cost estimate of 100 million Euro is only slightly more likely to occur than the high and low ends of the range.



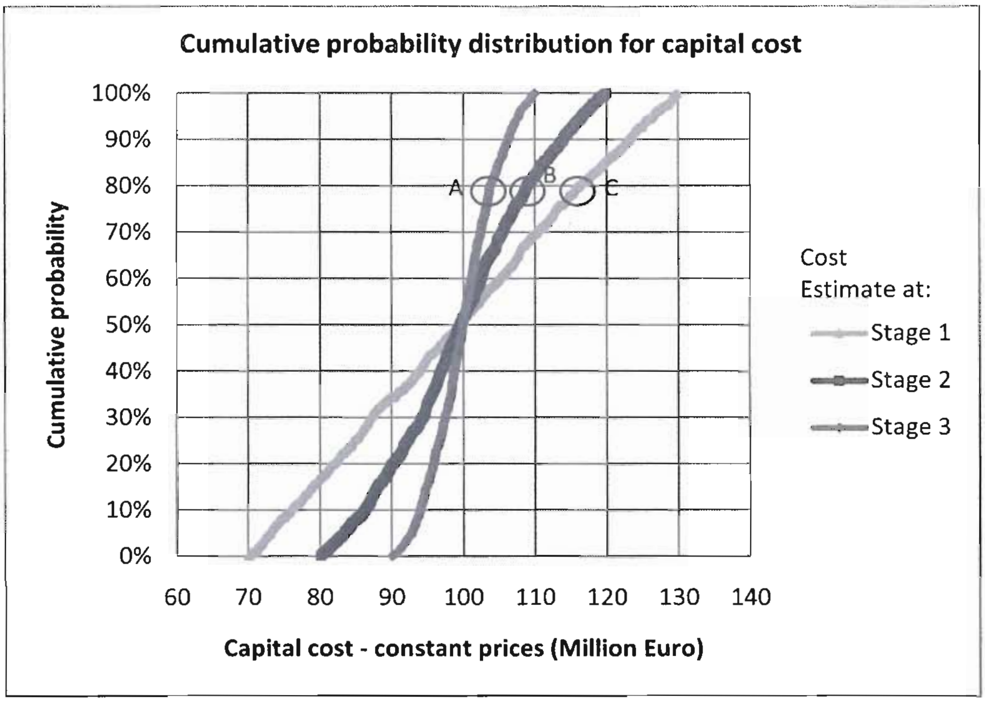
The next figure shows the possible range of the cost estimate at outline design stage. As the project is now more developed, the risks affecting the capital cost have decreased and there is a higher probability that the cost will be the base estimate of 100 million Euro. The possible range of the costs also narrows.



At the third stage in project development, when detailed design is carried out immediately before the tender, the range of possible capital costs is narrower still as the design now has a high level of certainty and the level of risk is lower. There is now a high probability that the final outturn cost will be the base cost estimate of 100 million Euro.



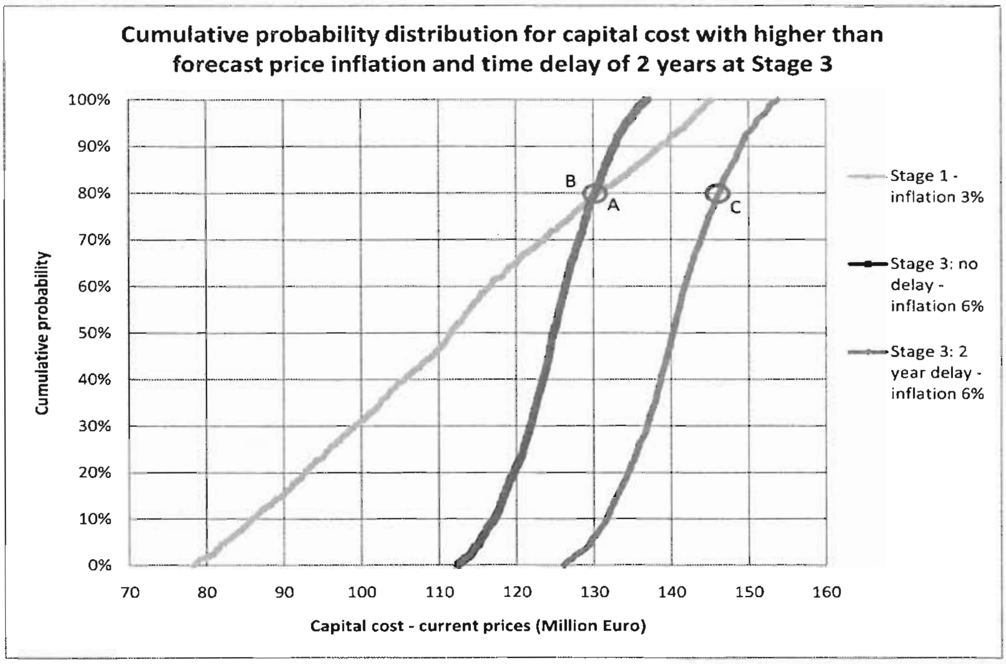
The required contingency for each stage can be determined using the distributions of the capital costs shown above. As the range of the costs narrows, the level of contingency needed lowers. The figure below shows the cumulative probability distributions for the capital costs at the three stages above.



To be 80% certain that the final outturn cost would not exceed the budget, at Stage 1 a contingency of 16.1 million (point C) would be needed. At Stage 2 this drops to 8.8 million (point B) and by Stage 3 a contingency of only 3.8 million (point A) is required. The Stage 1 contingency required on this basis is 16% of the base cost estimate, higher than the contingency of 10% allowed in the funding application.

However, the above considers the capital costs only in constant prices and does not take account of price inflation. It is important to make adequate provision for price inflation as an inadequate allowance, either due to higher than forecast cost inflation or to delays to the project can greatly increase the project cost.

The figure below shows the cumulative probability distributions for Stages 1 and 3 in current prices. At Stage 1, annual price inflation was forecast at 3%. It was anticipated that construction would start 27 months after Stage 1 and take place over 3 years, with a 33.3%/33.3%/33.3% spread of the capital costs over the construction period. This gives a base estimate of the capital cost in current prices of 110.1 million Euro. However, at Stage 3 actual annual price inflation was higher than forecast at 6% per annum rather than the 3% which was forecast originally. The base cost estimate in current prices with this higher price inflation is 121.0 million Euro. If there was then also a delay of two years to the start of construction, giving a start after 51 months rather than 27 and therefore a further two years of price inflation, the base capital cost estimate in current prices is 135.9 million Euro at Stage 3.



This shows the large effect that a combination of higher than forecast price inflation and time delays can have on the project cost and the importance of allowing adequate contingency and price adjustment for this. At Stage 1, to be 80% certain that there would be no cost overrun, a budget of 130.4 million Euro (point A) is required. At Stage 3, even if price inflation had been 6% per annum rather than the forecast 3% then the contingency could still be reduced slightly due to the increased certainty of the costs. With the same appetite for risk a budget of 130.2 million Euro (point B) would be needed. However, if at Stage 3 a two year delay to the start of construction occurred in addition to higher levels of price inflation, a much higher contingency would be needed. With a willingness to accept an 80% probability that there would be no cost overruns, a budget of 146.2 million Euro (point C) is needed, an increase of 16.0 million Euro from Stage 1.

Actual Price Inflation

The table below shows the annual average consumer price inflation in each country for the period 2005-2009 as would have been forecast based on 1998-2004 compared with the actual annual inflation over this period. This shows considerable variation between countries. For several countries (CZ, EST, LAT, LITH), annual inflation over the period 2005-2009 has been higher than for 1998-2004, therefore it is likely that allowances made for price inflation in these countries were inadequate. The remaining countries (who had higher levels of inflation in 1998-2004 than the four countries mentioned previously) had lower annual inflation over the period 2005-2009 than would have been forecast based on data from 1998-2004. They may therefore have made too high an allowance for price inflation. This particularly applies to BUL and ROM, who experienced very high inflation over the period 1998-2004.

	Forecast annual inflation 2005-2009*	Actual annual inflation 2005-2009
Lithuania	1%	6%
Czech Republic	3%	4%
Latvia	3%	9%
Estonia	4%	5%
Poland	5%	2%
Slovenia	7%	3%
Slovakia	8%	3%
Bulgaria	14%	4%
Romania	29%	6%

* Based on actual inflation 1998-2004

Glossary of Technical Terms and Abbreviations

Project

CFPM	Cost Forecasting and Programme Management
ToR	Terms of Reference
RCF	Reference Class Forecasting
DCR	Data Collection Report

Beneficiaries / State Ministries

NRIA / RIA	Bulgarian National Road Infrastructure Agency
NRIC	Bulgarian National Rail Infrastructure Company
BDZ	Bulgarian State Railways
RSDCR	Czech Republic Road Administration
SŽDC / CD	Czech Railways
SFDI	Czech State Transport Infrastructure Fund
ČSÚ / CZSO	Czech Statistical Office
ERA	Estonian Road Administration
LSR	Latvian State Roads
LD / LDZ	Latvian Railways
LRA	Lithuanian Road Administration
LG	Lithuanian Railways (Lietuvos Gelezinkeliu)
TID	Lithuanian Transport Investment Directorate
MoTC	Lithuania Ministry of Transport and Communications
RMDP	Lithuania Road Maintenance and Development Programme
GDDKiA	Polish General Directorate for National Roads and Motorways
PKP	Polish State Railways
MOI	Poland Ministry of Infrastructure
MRD	Poland Ministry of Regional Development
NCMNR / RNCMNR	Romanian National Company for Motorways and National Roads
CFR	Romanian Railways
NDS	Slovakian National Motorway Company
SSC / SRA	Slovak Roads Administration
ZSR / SR	Slovak Railways
MTPT	Slovakia Ministry of Transport, Posts and Telecommunications
DARS	Slovenian Motorway company
DRSC	Slovenian Road Agency
DfT	UK Department for Transport
MoT	Ministry of Transport
MoF	Ministry of Finance
MA	Managing Authority

EU/ International

JASPERS	Joint Assistance to Support Projects in European Regions
EIB	European Investment Bank
OP	Operational Programme
OPT	Operational Programme Transport
EBRD	European Bank for Reconstruction and Development
IFI	International Financial Institutions
Phare	Programme of Community aid to the countries of Central and Eastern Europe
DG Regio	Directorate General for Regional Policy
PPR	Project Progress Report
PCR	Project Completion Report
IMF	International Monetary Fund

TEN-T	Trans-European Transport Network
TEM	Trans-European North-South Motorway
MDB	Multilateral Development Banks
ISPA	Instrument for Structural Policies for Pre-Accession
OJEU	Official Journal of the European Union
WB	World Bank

Contracts

FIDIC	International Federation of Consulting Engineers
PPP	Public-Private Partnerships
D&B	Design and Build
ITT	Invitation to Tender
PAC	Price Adjustment Clause
PRAG	Practical guide to contract procedures for EC external actions
PBMC	Performance-based maintenance contracts
YB	Yellow Book (FIDIC)
RB	Red Book (FIDIC)
PQQ	Pre-qualification questionnaire

Risk Management

RM	Risk Management
QRA	Quantitative Risk Analysis
PRM	Programme Risk Management
RMP	Risk Management Plan
RE	Risk Exposure
EMV	Expected Monetary Value
OB	Optimism Bias
RMG	Risk Management Group

Value Engineering

VE	Value Engineering
VM	Value Management
VA	Value Analysis

Costing, Prices and Economics

RPI	Retail Price Index
CPI	Consumer Price Index
RCPI	Road Construction Price Index
NSO	National Statistics Office
BoQ	Bill of Quantity
QS	Quantity Surveying
CBA	Cost Benefit Analysis
TEE	Technical/Economic Evaluation of Projects
NPV	Net Present Value
FIRR	Financial Internal Rate of Return
FG	Funding Gap

Railways

UITP	International Association of Public Transport
OLE	Overhead Line Equipment

LRT	Light Rail Transit
TSI	Technical Specification for Interoperability
UIC	International Union of Railways
GSM-R	Global System for Mobile Communications – Railway
IM	(Railway) Infrastructure Manager

Other

BAU	Business As Usual
PSA	Property Services Agency
HGV	Heavy Goods Vehicle
FSU	Former Soviet Union
QA	Quality Assurance
STES	Technical, Economical, Social and Environmental studies