ASSESSMENT OF HIGH SPEED RAIL PROJECTS: SELECTION OF EUROPEAN CASES AND RECOMMENDATIONS FROM EVA-TREN RESEARCH

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ABSTRACT

The appraisal of large-scale transport projects is less than reliable : the EU Cohesion Fund programme reveals (2006) that one project in four costs more than 20% above budget, while only one in five stands below + 10%. Some experts even estimate that "*nearly 9 out of 10 projects fall victim to significant cost overruns*" (Flyvbjerg, 2004). Deviations in cost, duration and environmental impact are especially problematic because such investments usually last several years, yield significant impacts and their costs reach billions of Euros.

This paper reviews the main results of the research projects that the European Union has launched to improve the appraisal of large-scale infrastructure dedicated to the Trans-European Networks (TEN). In Europe, such projects are assessed according to two different scales: an environmental impact assessment (EIA) provides an estimation of the effects of the project on humans, fauna, flora and other ecological issues, while an economic analysis attempts to transform all costs and benefits (CBA) of the project into monetary units. However, in practice, the EU countries apply appraisal frameworks that differ considerably in scope, sophistication, methodology and parameter values. Communication of results also differ in a case-by case manner.

Based on recent research activities undertaken by EVA-TREN consortium (2006-2008) and on other international inputs, this contribution investigates the causes of deviation between project appraisals and results after the projects have been implemented. It concludes with recommendations for enabling capitalisation and communication of knowledge upon transport appraisal experience over the continent.

Keywords: Infrastructure planning, Project appraisal, Assessment methods, Trans-european networks, International comparison, Cost-benefit analysis, Demand evaluation, Reference class, TEN, HST, HSR, AVE, ICE, TGV, EVA-TREN

1. INTRODUCTION

The appraisal of large-scale transport projects is less than reliable : the EU Cohesion Fund programme reveals (The World Bank, 2006) that one project in four costs more than 20% above budget, while only one in five stands below + 10%. Some experts even estimate that *“nearly 9 out of 10 projects fall victim to significant cost overruns”* (Flyvbjerg, 2004). Deviations in cost, duration and environmental impact are especially problematic because such investments usually last several years, yield significant impacts and their costs reach billions of Euros.

European Union’s EVA-TREN project (EVA-TREN, 2008) has investigated the deviation of construction costs in several large-scale European projects. Amongst these projects, the authors -who contributed to EVA-TREN consortium- have selected 6 case studies for which data are most reliable. Those are mainly high-speed rail links: ICE Frankfurt-Cologne, Eurotunnel, Madrid-Seville AVE, Paris-Lille TGV, Lyon-Marseille TGV, and the Oeresund Fixed Link. Costs overruns lay between 8% (Lyon-Marseille TGV) and 116% (ICE Frankfurt-Cologne). This paper focuses on EVA-TREN high-speed rail results; readers interested in road traffic forecast issues may be interested in reading Bain's comprehensive study (2009) on errors and optimism bias in toll road traffic forecasts and Vassallo's work on overestimation in PPP contracts (2007).

2. CONSTRUCTION COST DEVIATIONS

The six case studies investigated ended up with cost overruns between 8% and 116%, on investments between 2’900 million Euros and 6’000 million Euros.

Table I – deviations in total construction cost

Projects	Forecast (million Euros)	Actual (million Euros)	Overrun (%)
ICE Frankfurt - Cologne	2784	6015	116%
Eurotunnel	2702	4568	69%
Oeresund Fixed Link	1795	2924	63%
Paris - Lille TGV	2666	3334	25%
Madrid - Seville AVE	3263	4029	23%
Lyon - Marseilles TGV	4015	4338	8%

Source: selected and adapted from EVA-TREN(2008), p. 45

Notes: ICE stands for “*InterCityExpress*”, the German HSR; TGV stands for “*Train Grande Vitesse*”, the French HSR; AVE stands for “*Alta Velocidad Española*” (with “*ave*” meaning "bird"), the Spannish HSR.

2.1 Project objectives

Before investigating the reasons for cost overruns, it is necessary to set these large-scale transport projects into their national and European context. This is important because the variety of stakeholders (regional, national and international institutions; multinational construction companies and rolling stock manufacturers) strongly influence the repartition of responsibilities – with the risk of diluting liability – and thereby makes project design and management much more complex than projects that would deal with national stakeholders only.

1. Frankfurt - Cologne ICE

The national objective of Frankfurt - Cologne ICE is to complete the German high speed rail network and to connect two regions which play a notable role in the German economy. More locally, the project aims at developing a common economic zone in the cities alongside the line between Frankfurt and Cologne. This project benefits the European Union because it contributes to the creation of the EU HSR network connecting Paris, Brussels, Amsterdam and London.

2. Eurotunnel

Eurotunnel has been launched in order to create a fast, all-weather, transport link between the UK and the Continent. The terminals at both ends of the tunnel were created in green fields and, simultaneously, linked to national rail networks. The connections have later enabled fast connections with high speed rail networks in France and in the UK. This link allows the European HSR network to cross the Channel and to connect with London.

3. Oeresund Fixed Link

The Oeresund Fixed Link provides a new road and rail connection between Sweden and Denmark. Both countries expect to gain strengthened cultural and economic collaboration. More locally, this fast link should enable to share labour and housing markets in the Oeresund region; it also enables Copenhagen and Skane regions to develop as a broad cross-border region. At European level, it provides an important element of the North - South transport axis.

4. Paris - Lille TGV

Paris-Lille TGV is a new high-speed train link that is intended to provide travellers with an alternative transport mode on heavily frequented Paris - Lille itinerary. It is expected to reduce the impacts of growing road congestion on A1 motorway. It shall stimulate industrial activity and tourism in the Nord Pas de Calais region and, simultaneously, it is helps connecting the Continental part of the European HSR with Eurotunnel, hence with the United Kingdom.

5. Madrid - Seville AVE

Spain aims at connecting all region' capitals to Madrid within 4 hours and to Barcelona within 6 hours. In this context, Madrid - Seville AVE project provides a key element of national railway modernization. More specifically, this new link shall unlock the Despenaperros bottleneck that restricts access to Andalusia. Madrid - Seville AVE belongs to the TEN-T priority axe that integrates Spain and Portugal into a fully interoperable trans-European HSR network.

6. Lyon - Marseilles TGV

Lyon - Marseilles TGV is the Southern part of the French HSR network that connects major cities to Paris. It improves the accessibility of regional metropoles (Avignon, Aix) to Paris and stimulates regional development near the new stations. This link fills the gap in the connection between France and Spain and thereby extends European HSR towards the South of the continent.

3. ELEMENTS OF PROJECT ASSESSMENTS

3.1. Types of project assessments used during decision-making process

Only a minority of projects have undergone a thorough assessment that includes –prior to construction (ex-ante) *as well as* after completion (ex-post)- a proper evaluation of demand, a financial analysis, an environmental assessment and a risk analysis. Elements of evaluation results are missing in most cases investigated, either because such data does not exist (several occurrences for ex-post finance and economic studies) or because it is not available to the public, which is a recurrent issue in Madrid – Seville AVE.

Table 2 – Components of project assessment that were used for decision-making

Assessments	Frankfurt – Cologne ICE	Eurotunnel	Oeresund Fixed Link	Paris - Lille TGV	Madrid - Seville AVE *	Lyon - Marseilles TGV
Demand Ex ante	+	+	+	+	O*	+
Demand Actual	+	+	+	+	+	+
Finance Ex ante	O	+	+	+	O*	+
Finance Ex post	O	+	+	+	+	+
Economic Ex ante	+	+	O	+	O*	+
Economic Ex post	+	O	O	+	+	+
Environmental analysis	+	O	+	+	O	+
Risk analysis	O	+	+	+	+	+

Source: selected and adapted from EVA-TREN (2008), p. 23
Legend: +: Available; O: Not available; * Existing, but not available because of confidentiality;

3.2 Main causes of costs deviations

Review of the six European high-speed rail infrastructure projects highlights seven potential causes for cost deviation. These are, by decreasing order of occurrence, delay in implementation (2/3), changes in project specifications and/or design, changes in environmental requirements (1/2), changes in safety requirements, technological risks as well as changes in quantity and prices (of rolling stock or material) (1/3) and, finally, underestimation of expropriation costs (1/6). The occurrences in brackets are conservative because Madrid – Seville AVE data is not counted (unavailable due to confidentiality).

Table 3 – Main causes of cost deviation and construction cost overrun

Potential causes	Frankfurt – Cologne ICE	Eurotunnel	Oeresund Fixed Link	Paris - Lille TGV	Madrid - Seville AVE *	Lyon - Marseilles TGV
Implementation delay	+	+	+	+		
Changes in project specifications & design	+	+	+			
Changes in environmental requirements	+		+	+		
Changes in safety requirements	+	+				
Technological risks	+	+				
Changes in quantity and prices		+		+		
Underestimation of expropriation costs						+
Cost deviation (% overrun)	116%	69%	63%	25%	23%	8%

Source: selected and adapted from EVA-TREN(2008), p. 46

Legend + Occurrence in the project that contributes to cost deviation.
* Existing data, but not available because of confidentiality.

All projects with cost overruns beyond 50% have gone through significant changes in specifications and design. All of them have also suffered from implementation delays; most of them have been adapted to match additional environmental and safety requirements, or technological risks.

With no less than 25% overcosts, Paris-Lille TGV has suffered construction delays, had to reduce its environmental impact to a level lower than initially planned, while rolling stock costs have increased. Still, its design has not been substantially modified. Little can be said about Madrid-Seville AVE because all documents that relate facts likely to explain cost deviations are being held confidential.

3.3 Quality of the demand analysis

Demand analysis is a crucial element for transport projects. Too optimistic demand forecast may wave the benefits of accurate management of project construction costs because the actual project, when implemented, may not generate sufficient revenues to balance costs. Demand forecasting is a major source of uncertainty and risk in the appraisal of large-scale projects. It should not only cover traffic volumes of a single mode, but it should also consider spatial traffic distribution and distribution between transport modes.

Table 4 – Features of demand analysis and accuracy of demand estimation

Demand analysis	Frankfurt – Cologne ICE	Eurotunnel	Oeresund Fixed Link	Paris - Lille TGV	Madrid - Seville AVE *	Lyon - Marseilles TGV
Demand analysis carried out	+	+	+	+	+	+
Demand analysis available/ public	O	+	+	+	O	+
Existing demand considered	+*	+	O	+	+*	+
Diverted demand considered	+*	+	O	+	+*	+
Induced demand considered	+*	+	O	+	+*	+
Competition taken into account	O	+	+	+	N.a.	+
More than one demand analysis produced	N.a.	+	O	+	N.a.	+
Scenario analysis of the demand	+*	+	O	+	N.a.	+
Overestimation occurred	N.a.	+	+	+	N.a.	O

Source: selected and adapted from EVA-TREN(2008), p. 43.

Legend: +: Yes; O: No; *: this item may have been calculated because it is required by the official methodology. However, it is not available to the public.

Table 4 indicates that all projects considered are backed by some form of demand analysis. Eurotunnel and Paris-Lille TGV have even undergone a very comprehensive demand analysis, which take all important issues into account. Such care did not, however, suffice to prevent demand overestimation. This questions the assumptions underlying such analyses as well as the conditions (economic optimism, political expectations) that surrounded the studies. Frankfurt-Cologne ICE's demand has been analysed, yet it remains largely confidential, such as Oeresund Fixed Link and, above all, Madrid-Seville AVE.

In the absence of facts and figures for public debate, there is little hope that discussion with stakeholders would help refining demand estimations, even though they are crucial for the project to meet the needs of society. In this sense, incomplete and/or confidential demand analysis not only contradicts basic democratic principles of decision-making, but also wastes the potential benefit to gain (often free) knowledge from all concerned parties for improving project design.

4. RECOMMENDATIONS

The above analysis, which stems from a selection amongst case studies of EVA-TREN project for the European Commission (EVA-TREN, 2008), leads to a series of recommendations for improving the quality of HSR projects. The authors, who are partners of EVA-TREN consortium, have selected within EVA-TREN recommendations those that make sense for rail infrastructure[1]. In addition to this, the authors propose further recommendations that take recent developments into consideration.

Recommendations are split in two groups. Firstly, methodological developments refer to three periods of project life: improvement of decision-support before project realisation, management and monitoring during construction, and development of knowledge after completion. Secondly, practical improvements propose ways of making best use of existing capabilities and knowledge.

4.1 Methodological improvements

4.1.1 Before project construction: comprehensive and evolutive decision-support

a) Use harmonised models and data

Decision-makers should be able to compare different transport projects on the basis of similar assumptions. EVA-TREN recommends (ibidem, pp. 124-125) that the European Union provides an harmonised database and that demand forecast would be broaden in terms of market and geographical scale. Data plays a key role for fuelling models, but it is not yet fully harmonised amongst all Member States.

In order to build a common reference framework, EVA-TREN advises to provide *i.* common socioeconomic data on a yearly- mid-term- and long-term horizons, *ii*. matrices of long distance traffic flows between EU regions, *iii*. a common references scenario for long distance demand projection and *iv.* reliable network attributes in terms of GIS network reference, such as speed, density and capacity.

Demand forecast should meet the following requirements: *i*. its geographic scale should allow to consider alternative routes, *ii*. its market segmentation should distinguish the main actors, *iii*. It should consider multimodality and the fact that competing transport modes will potentially react (especially in terms of tariff reductions), *iv*. model outputs should enable direct comparison with project objectives.

Harmonised models and data do not only matter at the beginning of the studies, but they also play an important role in anticipation of ex-post evaluation coherence with ex-ante studies.

b) Consider the full project cycle

EVA-TREN recommends to clearly identify the most important stages that pave project evolution between preliminary appraisal and ex-post evaluation (ibidem, p. 121) and, on the

[1] EVA-TREN tackled global energy and transport issues, whereas this paper focuses on specific high-speed rail projects.

basis of this segmentation, to anticipate potential conflicts that may slow the decision-making process. This suggests that the first assessments are undertaken at global level and that the evaluation procedures are progressively refined. From the first stages onwards, is also important to prepare a framework that will, later, enable a coherent ex-post evaluation. This means that potential changes and implementations problems are considered (and reported) as soon as they arise, and that their potential impacts are estimated.

c) Adopt a dynamic approach to ex-ante appraisal

As the project evolves most rapidly during the first stages, it is not relevant to produce a single, rigid assessment at this period. However, during the earliest phases, most attention should be devoted to clearly design the decision-making process itself. After this framework has been established, it is possible to estimate the impacts of potential changes of objectives, decision delays, and implementation issues on expected outputs.

d) Use a progressive approach to environmental analysis

EVA-TREN consortium states that environmental priorities have little influence on whether or not the project should be implemented (ibidem, 2008, p. 122). Nevertheless, the benefit of Environmental Impact Assessment (EIA) merely lies in the fact that it helps to organise the public debate and, thereby, contributes to reach consensus. This implies that the project should be re-appraised after each significant modification, and that the impacts of such modification should be made public. In this perspective, environmental analysis becomes more thorough while project progresses, as it is the case for the entire ex-ante appraisal.

e) Perform quantitative risk analysis

Estimation of impacts, costs and benefits inevitably implies assumptions and uncertainties. In order to reduce uncertainties as well as the impact of their potential outcomes, it is necessary to analyse risks. This requires identifying the probability and the significance of the main risks that the project may face. To do this, it is useful to refer to groups of projects that are similar to the one under development ("reference class forecasting", Flyvbjerg, 2004).

4.1.2 During construction: management and monitoring

a) Monitor project development

As project construction lasts several years, many things may happen and impact cost, schedule, or operation. In this context, it is essential to constantly monitor how the project progresses as well as how the context into which it shall be implemented evolves. To do this, it is necessary to elaborate a monitoring system with a checklist that not only points to investment costs and work progress, but that also includes indicators of the socioeconomic context, of the transport context, as well as the expected impact of the project in terms of transport demand, supply and its environmental impact.

b) Adopt risk management and mitigation strategies

The quantitative risk analysis (above) highlights the most critical issues. On this basis, it is useful to develop risk management strategies and strategies that mitigate impacts of the detrimental events, should they occur. EVA-TREN recommends (p. 123) to allocate the responsibility of managing risks to specific entities, and (p. 48) to require them to react quickly in case project indicators deviates from initial estimations, even slightly.

f) Combine assessment methods

Decision on whether to launch, to amend or to stop a large-scale transport project is generally based upon the results of a cost-benefit analysis (CBA). Benefits should be greater than costs for the project to proceed. The decision is easy when the difference between the two is clear. However it may happen that studies report costs and benefits of similar values. And scholars know that outcomes of valuation techniques (such as CBA) include margins of error, and that the monetary values used may arise from items for which prices have little meaning. In such conditions, the CBA method itself cannot provide further help for decision. This is why some countries, such as Japan, combine CBA with multicriteria analysis (Chevroulet, 2008, p. 12). The Japanese evaluation proceeds in two steps: the project may progress if the benefit/cost ratio is larger or equal to 1.2, but, if the ratio is smaller than 1.2, then the project is re-appraised via a multicriteria analysis, with consideration of all intangible effects (Japan Research Institute, 2000). A similar procedure might be of great help in Europe when CBA provide results that display insufficient contrast for decision-making.

4.1.3 After construction: development of knowledge

a) Systematically perform ex-post evaluations

Ex-post evaluations clarify the relationship between investments made and objectives actually achieved in terms of finance, economics as well as social and environmental issues. The results of such evaluations serve two purposes. Firstly, they help adjusting operation variables, such as fares or competition conditions in case several operators are involved. Secondly, they help improving future ex-ante evaluations of similar cases.

b) Make maximum use of evaluation results

Basic requirements of decision-making in a democratic system entail communication of key figures of large-scale transportation projects for at least two reasons: 1. the project under discussion involves a substantial part of regional/national/Union budget, which initially, comes from taxpayers (citizen and businesses); 2. high speed rail infrastructures are expected to generate significant impact on society and on the economy as well as on the environment. As a consequence, it is essential that results of evaluations are made public and that authorities listen (which does not mean “obey”) to stakeholders who have their own reasons to express their opinion and may thereby share their own knowledge (in particular interest groups and specialized NGOs). Such dialogue does of course require time and resources, yet such investment pays off in the sense that it helps building up knowledge with each project, and this experience can then improve assessment and design of future projects.

4.2 Practical improvement

a) Establish a supporting team at EC level

EVA-TREN stresses the need for harmonisation, or comparability of assessments. One of the possibilities to help assessors reach a given, universal, quality standard is to provide support. To do this, the Dutch government has set a "*Support desk for Economic Evaluation*" (SEE[2]) which helps project developers answer questions about economic evaluation of infrastructure (Chevroulet, 2008, p. 8). SEE provides support for practical questions about economic evaluation as well as general information at national and international level.
A more recent initiative from the European Commission is to require its TEN-T Executive Agency[3] to follow-up the preparation and subsequent implementation of transport projects, and to emphasise information and communication on projects (TEN-T EA, 2009, Objectives for 2009). EVA-TREN (2008, p. 125) recommends that this Agency would also support collection and capitalisation of evaluation studies and would provide harmonised inputs for project appraisal.

b) Build up an open database

If scientists and practitioners are expected to achieve more systematic project appraisal, they need to access data about a wide range of past and present project evaluations. If no co-ordinated action is taken at EU level, then large construction companies, some states and universities may build up their own databases, which would de facto remain partial, and to which they can restrict or monetise access, This segregation would entail a significant loss of knowledge and thereby impact on the quality of future appraisal. Therefore, it is crucial for the European Union to take the lead in the constitution of a structured, wide-ranging and open database for project evaluation.

5. CONCLUSIONS

The study of six European high speed rail projects highlighted that cost overruns constitute a standard rather than single accidents. The issue is problematic because the deviation is important (between 8% and 116%) and it relates to substantial amounts (between 3 billion Euros and 6 billion Euros).
The most important reasons for these deviations are the inaccuracy of demand estimation (hence overestimation of future revenues), the unplanned changes in project specifications, the rise of environmental and safety requirements, the occurrence of technological risks and unexpected changes in rolling stock or material costs.
When dealing with these issues, practitioners and scientists produce forecasts, which entail uncertainties. To reduce these uncertainties to an acceptable level, these specialists need to be able to compare the projects of interest with other, similar, projects for which assessment results are compared with actual facts. This implies three things. Firstly, there is a need for EU-harmonised procedures in high speed rail project assessment. This will ensure that every

[2] SEE means "*Steunpunt Economische Evaluatie*". See: www.rwa-avv.nl/SEE
[3] The TEN-T EA has been created by the European Commission in 2006.

Member State can benefit from lessons drawn from projects made in another Member State. Secondly these procedures should require that ex-ante studies are compared with actual results (ex-post), and they should require that deviations are explained so that knowledge is improved. Thirdly, for these efforts to have an impact in practice, it is crucial that information is shared amongst stakeholders. This implies that evaluation results are made public, that institutions foster dialogue with citizen and organisations, even though it is time and energy-consuming; information sharing also implies the organisation and creation of an EU-harmonised database that gathers a wide range of project evaluation results; benefit of harmonisation and use of such database would in turn increase if the European Commission even more actively supports those in charge of appraising projects.

As a concluding remark, the authors stress that appraisal quality would progress faster by building up the above-mentioned harmonised assessment and communication framework, then it would through pure scientific research in cost-benefit analysis. Both being of course necessary in the long term.

6. ACKNOWLEDGEMENTS

The authors wish to thank all participants of EVA-TREN consortium, and above all, Dr Silvia Maffii (TRT), project coordinator.

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