EVALUATION OF TRANSPORT INFRASTRUCTURE PROJECTS ON CORRIDORS BY A STRATEGIC ASSESSMENT FRAMEWORK

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Abstract
The present paper illustrates the strategic assessment framework applied for the appraisal of large-scale infrastructure projects with European importance. The methodology has been developed within the TEN-STAC project (Scenarios, Traffic Forecasts and Analysis of Corridors on the Trans-European Network, project funded by the European Commission, Directorate General Transport and Energy) and applied for the assessment of 69 infrastructure projects belonging to 22 European transport corridors according to 32 impact criteria. The infrastructure projects under evaluation belong to trans-European transport corridors – hence the perception of infrastructure projects as components of transport corridors is considered by the evaluation approach. The assessment approach includes various types of impact criteria, like monetary criteria and intangible ones or quantitative and qualitative ones. According to the way performance data are generated for the impact criteria, the criteria are subdivided into four classes: the impact criteria based on transport impedance matrices, impact criteria based on transport flows on the project, impact criteria based on transport flows in the whole transport system and impact criteria independent from modelling results.

Keywords: Transport modeling; Project assessment; Europe; Transport network; Corridor assessment; Transport corridor; Transport infrastructure policy; Multi-criteria analysis; Impact analysis
Topic area: E1 Assessment and Appraisal Method w.r.t. Transport Infrastructure Projects and Transport Activities

1. Introduction

The present paper intends to illustrate the Strategic Assessment Framework applied for the appraisal of large-scale infrastructure projects with European importance. The methodology has been developed within the TEN-STAC project[1] and applied for the assessment of 69 infrastructure projects belonging to 22 European transport corridors according to 34 impact criteria.

In the last decades European transport infrastructure planning has been determined strongly by the planning of “networks” and “corridors”. These two kinds of perception of the scope of infrastructure planning “must not be opposed, but, on the contrary, considered as complementary” (Reynaud 2003), like the definition of trans-European networks (TEN) in EU member states and the definition of priority corridors in Central Eastern European Countries. The most recent approaches by European transport infrastructure planning fortify

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[1] TEN-STAC: Scenarios, Traffic Forecasts and Analysis of Corridors on the Trans-European Network. Project funded by the European Commission (Directorate General Transport and Energy).

the corridor notion. For bridging the gap between the consideration of either only one link or a whole network, the notion of a "corridor" represents an adequate scope for transport planning at large-scale, international level. Hence a corridor represents a set of links being directly connected with each other, which form part of a transport network, that for certain reasons distinguishes itself from other parts of the network. The Strategic Assessment Framework presented in the paper illustrates a methodology for transport infrastructure project assessment, whose scope is not restricted solely to an assessment at project level, but whose scope incorporates the dimension of the whole transport corridor the project is embedded in.

The paper is organised as follows: Chapter 2 illustrates the scope of the Strategic Assessment Framework in terms of infrastructure projects and criteria taken into account, whereas the chapter 3 is devoted to the description of the general methodology for the generation of project-specific performance data by type of impact criteria. Furthermore, in chapter 3 special attention is paid to the modelling system applied and to the approach how the generated performance data are transferred to scores. Chapter 4 contains the summary and the conclusions to be drawn.

2. Scope of the strategic assessment framework

2.1. Development of transport infrastructure planning at European level

The Treaty of Rome has set the basis for European integration in 1957, by the foundation of the European Economic Community (EEC). Apart from external trade and agriculture the field of transport policy was explicitly mentioned in the Treaty as an instrument for European integration. However, the vague definition of Common Transport Policy (CTP) in the Treaty turned out to hamper the development of a European transport market and the planning of transport infrastructure at the European level (Turró 1999).

In 1962, the "Action Programme for the Implementation of a Common Transport Policy" was issued, in which the positive impact of transport infrastructure on economic development was stressed, as well as the potential of deregulated transport markets for an improvement of efficiency. Two years later, in 1964, the draft decision for Community control of infrastructure investment highlighted the requirement of co-ordinating transport infrastructure investments at the Community level.

In 1979 the European Commission issued the first document solely devoted to transport, "A Transport Network for Europe: Outline of a Policy". This publication contains "categories of investments" (Turró 1999), which were identified as being of fundamental importance for the Community, like elimination of major bottlenecks or construction of fixed links in order to overcome natural obstacles.

The Single European Community Act agreed on in 1985 provided the basis for transport policy on the trans-European Network (TEN).

In 1990 the high-level group on the European High-Speed Train Network published a report, in which the development of a European high-speed network was proposed, which implied the requirement of the construction of about 9000 kilometres of new lines and the upgrading of about 15000 kilometres of existing links. Furthermore, the high-level group identified 15 "key links". In the same year the Commission published the document "Towards trans-European networks", with the main target to create awareness for and acceptance of the TENs as an important policy and interest of the Community – a step, which has been acknowledged as indicating "a quickening of the pace towards a genuine Community infrastructure, and certainly a consensus as to the main priority areas" (Vickerman, 1991).

The Maastricht Treaty approved in 1992 marked the initiation of a European transport infrastructure policy: by emphasising the importance of trans-European Networks as a "natural consequence of the single market" (Button et al, 1998), and stressing the importance of improving interconnection and interoperability of the core networks, the Article XII of the Maastricht Treaty “heralds the birth of the European Union” (Button et al, 1998).

The decisive milestone on the way to a consolidated approach for initiating transport infrastructure measures at large-scale level had its origin in the decisions made on the EU summit in Essen in 1994. The result of this summit was an agreement on a list of fourteen large-scale priority projects (1962/96/EC; Annex III), which was based on a project list drawn up by the European Commission and further elaborated by an advisory committee[2] initiated by the European Council.

The extension of transport infrastructure to Central and Eastern European countries was discussed during the Pan-European transport conference in Prague in 1992, on Crete in 1994 and in Helsinki in 1997.

Despite of the definition of trans-European transport networks and agreement on the 14 priority projects the implementation of the infrastructure measures has been proceeding sluggishly, mainly due to legal, administrative and political matters, budgetary constraints and lack of information on technical and economic items (COM(98) 614). In the White Paper issued by the European Commission in 2001 (EC 2001) the importance of a completion of the priority projects is emphasised, as well as the requirement of expanding the set of priority projects by eight further projects and for adapting the funding rules. The White Paper also announced a proposal for a revision of the guidelines for the development of the TENs, which – together with the extended list of priority projects – was officially submitted to the European Parliament and the Council in the same year (COM/2001/544 final). Further steps towards a revision of the guidelines for the TENs were brought forward by

- the implementation of a high-level group on the trans-European Transport Network, whose objective was to identify the priority projects of the trans-European transport network up to 2020 on the basis of proposals from member states and the acceding countries (HLG on the TEN, 2003),
- the setting up of a project on “scenarios, traffic forecasts and analysis of corridors on the Trans-European network”, TEN-STAC,
- the formation of the TEN-T Committee acting as a representation of Member States and acceding countries,
- and the establishment of an interdisciplinary task force at the European Commission.

Finally, in October 2003 the European Commission issued a proposal for a decision of the European Parliament and of the Council amending the guidelines for the development of the trans-European transport network (COM(2003 564 final)). The list of priority projects consists of the extended list of priority projects of the year 2001 (see COM/2001/544 final), as well as of recommendations by the high-level group on the trans-European Transport Network and reactions received after the publication of the high-level group’s report. These projects are illustrated by Figure 1.

The only project being not subject to assessment by the Strategic Assessment Framework is Galileo, a new satellite radio navigation system[3] enabling a positioning of users in many sectors such as transport (e.g. vehicle location, route searching, speed control, guidance systems).

[2] The advisory committee was chaired by the Vice-President of the European Commission Herning Christophersen and is also known as “Christophersen Group“.
[3] See e.g. http://europa.eu.int/comm/dgs/energy_transport/galileo/index_en.htm

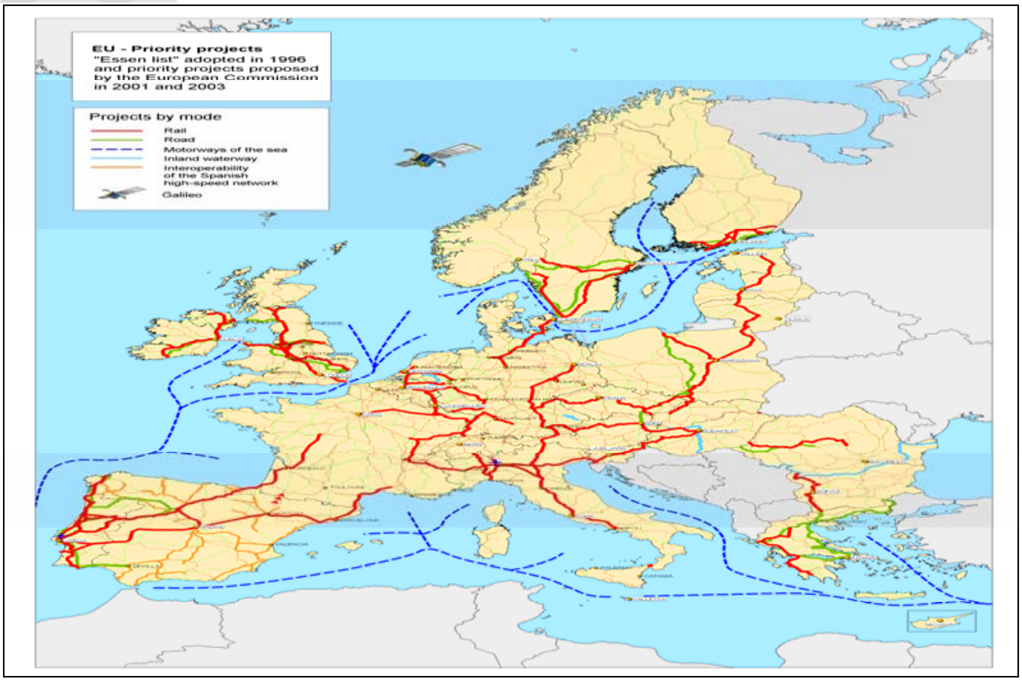


Figure 1: Transport infrastructure priority projects of the European Union

2.2. Criteria for the project appraisal

A multidimensional evaluation of public investments "has to be based on a broad and representative set of criteria", which "may be different in nature" (Nijkamp 1994). By listing the requirements priority projects have to meet, the Article 19 of the publication by the European Commission mentioned above (COM (2003) 564 final), sets up a framework for a broad set of criteria to be considered by the Strategic Assessment Framework.

The relationship between the criteria of the EC publication and the referring group of impact variables is illustrated by Table 1.

Table 1: Criteria in the relevant EU publication and corresponding group of indicators applied for project appraisal

Criteria as specified in COM 2003/564, Art.19	**Corresponding group of impact variables considered**
(a) (priority projects) aim to eliminate a bottleneck or complete a missing link on a major route of the trans-European network, in particular projects which cross natural barriers;	REDUCTION OF CONGESTION AND BOTTLENECKS
(b) (priority projects) are on such a scale that long-term planning at European level brings high added value;	CREATION OF EUROPEAN VALUE ADDED GENERAL TRANSPORT RELEVANCE
(d) (priority projects) provide significant added value in facilitating the mobility of goods and people between Member States, including contributing to the interoperability of national networks;	
(c1) (priority projects) demonstrate, in terms of the overall project, potential socio-economic profitability and other socio-economic advantages	FINANCIAL AND ECONOMIC SUSTAINABILITY CREATION OF ECONOMIC VALUE ADDED

Table 1 continued

Criteria as specified in COM 2003/564, Art.19	**Corresponding group of impact variables considered**
(c2) (priority projects) demonstrate, a commitment on the part of the Member States concerned to carrying out the studies and evaluation procedures in time to complete the work in accordance with a date agreed in advance;	MATURITY AND COHERENCE OF THE PROJECT
(e) (priority projects) contribute to the territorial cohesion of the European Union by integrating the networks of the new Member States and improving connections with the peripheral regions;	IMPROVEMENT OF COHESION / ACCESSIBILITY
(f) (priority projects) contribute to sustainable development of transport by improving safety and reducing environmental damage caused by transport, in particular by promoting a modal shift towards railways, intermodal transport, inland waterways and maritime transport.	SUSTAINABILITY

In the next step the group of criteria have been specified further and have been made operational for the project assessment task. Hence for each group of indicator the referring impact criteria have been selected, so that the chosen impact variables reflect the criteria of the EC document mentioned above in a most appropriate way.

Table 2 gives an overview of the impact criteria taken into account for the project evaluation. It includes various types of impact criteria, like monetary criteria and intangible ones or quantitative and qualitative ones. The performance of the criterion "Economic sustainability" condenses the performance of several other criteria, e.g. financial sustainability, changes in travel time or emission loads measured in monetary terms. This indicator has been implemented in the Strategic Assessment Framework in order to integrate all impacts, which are considered in monetary terms and which are usually considered for the calculation of a cost/ benefit ratio. When attaching weights to criteria the integrating function of this criterion has to be acknowledged in order to avoid double counting.

Table 2: Evaluation criteria

#	Objective or criterion	Indicator	Unit of measure
REDUCTION OF CONGESTION AND BOTTLENECKS			
1	IMPROVEMENT OF ROAD LEVEL SERVICE	Changes in time costs caused by road congestion	€/year
2	REDUCTION OF TRAVEL TIME	Changes in monetary value of the reduction of passenger travel time	€/year passenger·hour/ year
3		Changes in monetary value of the reduction of freight travel time	
CREATION OF EUROPEAN VALUE ADDED			
4	DEVELOPMENT OF INTERNATIONAL PASSENGER TRAFFIC	Share of international passenger traffic on total traffic on the project	%
5		Volume of international passenger traffic on the project	passenger/ year
6	DEVELOPMENT OF INTERNATIONAL FREIGHT TRAFFIC	Share of international freight traffic on total traffic on the project	%
7		Volume of international freight traffic on the project	ton/ year
8	INTEROPERABILITY	Reduction of passengers waiting time at borders for international traffic	passengers·hour
9		Reduction of freight waiting time at borders for international traffic	ton·hour
10		Length of networks becoming interoperable because of the project	km
GENERAL TRANSPORT RELEVANCE			
11	TOTAL TRAFFIC VOLUME ON THE PROJECT	Total passenger traffic on the project section	passenger/ year
12		Total freight traffic on the project section	ton/ year
13	INTERMODALITY	Qualitative appraisal of the project's contribution for an intermodal transport system	-
FINANCIAL AND ECONOMIC SUSTAINABILITY			
14	FINANCIAL SUSTAINABILITY	Ratio among project total cost and estimated cost per that kind of work	ratio
15	ECONOMIC SUSTAINABILITY	Ratio 2020 monetary benefits / project total cost	ratio
MATURITY AND COHERENCE OF THE PROJECT			
16	DEVELOPMENT OF THE PROJECT	Appraisal of the project planning status	-
17	INSTITUTIONAL SOUNDNESS	Qualitative appraisal of the project's compliance with national plans	-
18	COHERENCE OF THE PROJECT	Qualitative appraisal of the project's coherence with main international traffic corridors	-
IMPROVEMENT OF COHESION / ACCESSIBILITY			
19	SOCIAL COHESION	Variation of the TEN-STAC centrality index for passenger transport	%
20	ECONOMIC COHESION	Variation of the TEN-STAC centrality index for freight transport	%
21	PERIPHERAL ACCESSIBILITY	Variation of the TEN-STAC centrality index for passenger transport in regions identified as peripheral	%
22		Variation of the TEN-STAC centrality index for freight transport in regions identified as peripheral	%
CONTRIBUTION TO SUSTAINABLE DEVELOPMENT			
23	MODAL REBALANCING	volume of road freight traffic shifted to rail, IWW or sea transport	ton·km / year
24		volume of road and air passenger traffic shifted to rail	passenger·km/ year
27	TRANSPORT SAFETY	Variation on monetary value of accidents	€/ year
28	GLOBAL WARMING	variation (in monetary value) of the transport contribution to global warming	€/ year tons CO2/ year
29	ATMOSPHERIC POLLUTION	variation (in monetary value) of the NOX transport emission	€/ year tons NOx/ year
30		variation (in monetary value) of particulates' emissions of transport	€/ year tons particulates/ year
31	LEVEL OF CONCERN: PROXIMITY	Synthetic appreciation of the proximity of the project from specially protected areas (SPAs) or densely populated areas	Proximity of the project from SPA (km) N. inhabitants living in the zone traversed by the project
32	LEVEL OF CONCERN: DISTANCE	Percentage of the length of the project lying in a sensitive area	%
33	LEVEL OF CONCERN: TRAFFIC TRANSFER	Transfer of traffic from infrastructure lying in sensitive zones to the projected infrastructure	% of road traffic transferred from sensitive areas
34	LEVEL OF CONCERN: EMISSIONS	Changes of inhabitants' level of concern caused by emissions of particulates	%

3. Methodology applied for project evaluation

3.1. Perception of projects as components of transport corridors

The methodology applied for project evaluation is determined by the perception of infrastructure projects as part of transport corridors. This perception is in line with the European Commission's view on transport infrastructure investments (see European Commission 2003).

This general approach of perceiving the transport infrastructure projects to be assessed as part of a transport corridor is reflected by the methodology applied for the project evaluation. Some performance criteria are raised directly at project level and for each project individually, whereas other performance criteria are raised for the projects seen as a part of a corridor.

For an illustration of the spatial extension of a "corridor" and a "project" Figure 2 displays the routing of the rail corridor Lyon – Milano – Ljubljana – Budapest. This corridor is subdivided into three "projects" as follows:

- Lyon – Mont-Cenis base tunnel – Torino – Milano
- Milano – Verona – Venezia
- Venezia – Trieste – Ljubljana – Budapest

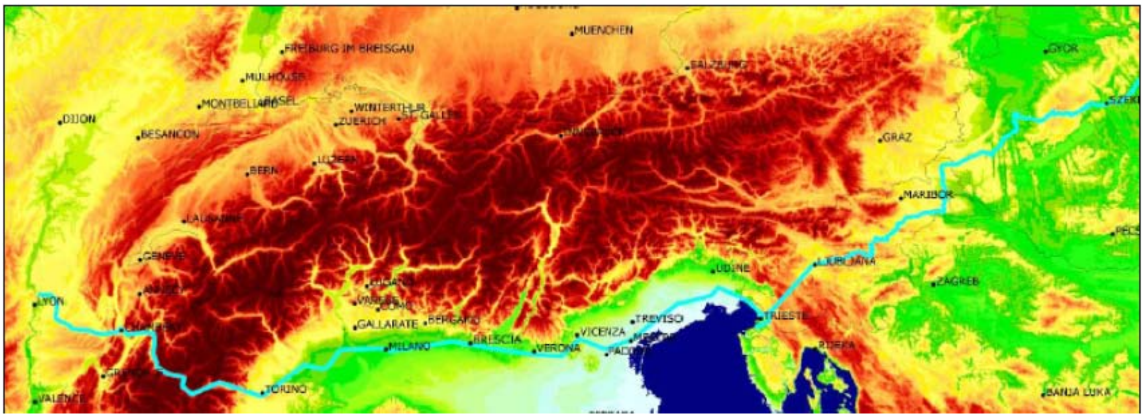


Figure 2: Example for an infrastructure corridor subject to evaluation by the Strategic Assessment Framework

3.2. Modelling system

The assessment methodology is largely based on two European transport models: the VACLAV model for passenger and the NEAC model for freight transport.

The VACLAV passenger transport model has been developed at IWW[4]. Its structure represents a classical four-stage transport model consisting of the stages generation, distribution, modal split and assignment. A detailed documentation of the VACLAV model can be found in Schoch (Schoch, 2003). The model's geographical scope is the whole European continent, with Russia, Belarus, Ukraine and the Balkan countries being considered as external zones. The zoning system of the traffic cells is in line with the regional structure by the European Union's statistical authority, Eurostat, and represents NUTS[5] 3 regions. This results to around 1,200 traffic zones and, hence, to 1.44 million origin/ destination (O/D) relations, for which the passenger transport volume is generated, differentiated by modes and trip purposes. The modes considered are road, rail and air; the distinction by trip purposes embraces business, holiday/ leisure and private. The stage of traffic generation is performed by a methodology, which for each population segment applies specific probabilities for the generation of trips for certain trip purposes. For the distribution of these trips to destinations a

[4] Universität Karlsruhe (TH); Institut für Wirtschaftspolitik und Wirtschaftsforschung (IWW), Germany.
[5] NUTS: Nomenclature of territorial units for statistics.

gravitation approach is applied. The modal split is calculated by a logit model being enhanced by a Box Cox transformation (Box and Cox 1964), which ensures a non-linear, asymmetric logit function and, hence, a more realistic description of mode choice (Mandel, Gaudry and Rothengatter 1997). For the allocation of traffic demand to the road network an incremental assignment method is applied. The rail assignment for passenger transport is highly dependent on the level-of-service offered, e.g. in terms of routings and frequencies of lines and possibilities for transfers. Therefore the rail assignment methodology relies on information on the level-of-service of high-speed trains and long-distance trains in Europe.

The NEAC freight transport model has been developed by NEA[6] and is based on an extensive freight transport database, in which the whole transport chain from the origin to the destination is represented, including the main transhipment locations, like terminals and ports. The NEAC freight transport database and modelling system distinguishes trade and transport demand flows. Trade flows are represented by the volume of trade between an O/D pair, while the transport flows represent the way in which the goods are moved between the zones. The basis for the generation of transport flows are the trade flows, with by the model are assigned to (intermodal) transport chains. The final transport chain is attained by a combination of following outputs from the freight model: the transport mode in the origin zone, the transport mode in the destination zone, and the transshipment region. The traffic zones implemented in the NEAC model are oriented on the NUTS 2 regions defined by Eurostat. The modes taken into account are road, rail, inland waterway, maritime transport and other modes (air, pipeline), whereas the demand side is represented by goods categories for ten NSTR[7] classes.

The stages of generation, distribution and modal split are processed by each transport model separately, whereas for the road assignment stage results of the two models are combined by the VACLAV model.

The network models applied for the assignment are based on GISCO[8] networks of the year 2002, whose data have been checked carefully and updated for the purposes of the reference situation and the assumptions on the infrastructure projects to be evaluated.

Results for the quantitative evaluation criteria are generated by separate routines being directly linked either to cost matrices or to assignment results. The applied modelling system is pictured by Figure 3 and illustrates how some of the impact criteria are connected to the different stages of transport modelling.

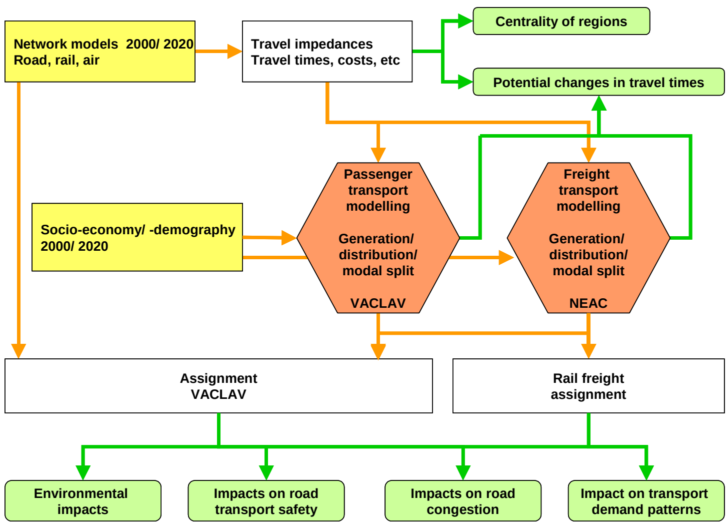


Figure 3: Modelling system

[6] NEA transport research and training, Rijswijk, The Netherlands.
[7] NSTR: Normenclature Statistiques Transports Reviseé
[8] GISCO: Geographic Information System of the European Commission

3.3. Reference situation

In order to allow a comparison of an infrastructure project's impact with a status-quo situation a reference situation for transport infrastructure assumptions has to be defined. The reference case represents following situation of network developments: all infrastructure changes in terms of upgrades or new links have been assumed, if their construction measure (upgrade/ new link) is planned to be finished before the year 2008. With several of the projects to be evaluated having a realisation horizon for the year 2020, the reference scenario represents a rather pessimistic view on the further developments on European transport networks.

3.4. Methodology for generation of performance data

According to the methodologies applied for the generation of performance data for quantitative impact variables the impact criteria can be subdivided into four groups (Szimba and Schoch 2003):

- Impact criteria based on transport impedance matrices (e.g. potential changes in travel times, centrality)
- Impact criteria based on transport flows on the project (e.g. share of international traffic)
- Impact criteria based on transport flows in the whole transport system (e.g. modal split, environmental indicators)
- Impact criteria independent from modelling results (e.g. appraisal of project planning status)

The methodology for the generation of performance results by groups of impact criteria is dealt with in the next sub-chapters.

3.4.1. Impact criteria based on transport impedance matrices

The estimation of performance data for impact criteria based on transport impedance matrices does not require the application of the transport models, as no transport demand reaction is considered. The impedances are derived from the infrastructure measures implemented in the network models. For the assessment of a project's impact on criteria based on transport impedances following two situation are compared: the situation in which the project i is realised, together with all other projects belonging to the corridor j, and the situation in which all projects on corridor j are realised besides project i (see Figure 4).

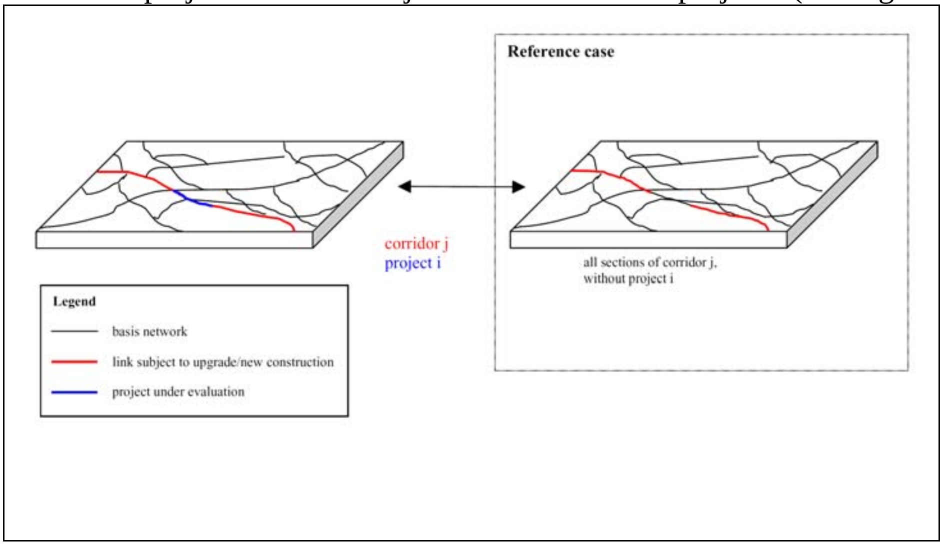


Figure 4: Reference case for project assessment for criteria based on impedance matrices

One criterion belonging to this group is “Changes in monetary value of the reduction of passenger travel time”. The estimation of performance data for this indicator is based on the passenger travel time matrices, which represent “potential” travel times, i.e. without the consideration of congestion effects or capacity restraints.
The passenger travel time differences resulting from a realisation of project i on corridor j, $TD_{pass}^{i,j}$, are estimated by following formula:

$$TD_{pass}^{i,j} = \sum_p \sum_l \sum_k \left((t_{kl}^{wo})^p - (t_{kl}^{w})^p \right) \cdot TV_{kl}^p$$

where

$(t_{kl}^{wo})^p$	potential travel time for an O/D relation (k, l) for trip purpose p, without realisation of the project
$(t_{kl}^{w})^p$	potential travel time for an O/D relation (k, l) for trip purpose p, with realisation of the project
TV_{kl}^p	travel volume on O/D link (k, l), differentiated by travel purpose p

In the next step the aggregated travel time differences are weighted by the country-specific values of time.

3.4.2 Impact criteria based on transport flows on the project

Impact criteria based on transport flows on the project, e.g. the total transport volume or the share of international transport demand, can be retrieved directly from the assignment results. Impact criteria belonging to this type are raised for each project without a comparison to a reference case.
As one example for an indicator of this group, the share of international passenger traffic on a project p, $\overline{IS}_{pass}^{p}$, is calculated as follows:

$$\overline{IS}_{pass}^{p} = \frac{\overline{TVI}_{i}^{pass}}{\overline{TV}_{i}^{pass}},$$

with $\overline{TVI}_{pass}^{p} = \dfrac{\sum_i l_i \cdot TVI_i^{pass}}{\sum_i l_i}$ and $\overline{TV}_{pass}^{p} = \dfrac{\sum_i l_i \cdot TV_i^{pass}}{\sum_i l_i}$

where

l_i	length of link i belonging to project p
$\overline{TV}_{p}^{pass}$	total passenger transport volume on project p
$\overline{TVI}_{p}^{pass}$	international passenger transport volume on project p
TVI_i^{pass}	international passenger transport volume on link i belonging to project p
TV_i^{pass}	total passenger transport volume on link i belonging to project p

3.4.3. Impact criteria based on transport flows in the whole transport system

The calculation of performance data for impact criteria based on transport flows in the whole transport system – thus covering all modes –, like criteria related to modal split or environmental criteria, requires the analysis of all traffic flows of all modes.

In a first step the assignment results are generated at corridor level. For these assignment runs the assumption is made that all projects belonging to the corridor under consideration are implemented.

Figure 5 illustrates the scope of the required assignment runs.

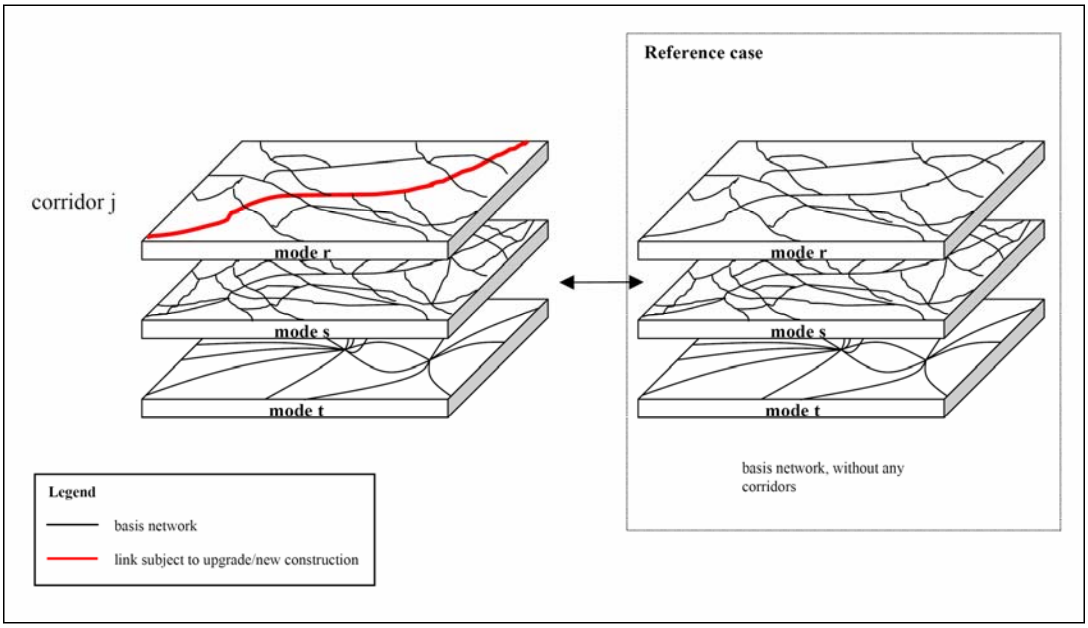


Figure 5: Assignment runs for impact criteria based on transport flows in the whole transport system

The changes in transport flows and related impact criteria have to be assessed at project level. Hence the assignment results at corridor level have to be transferred to the project level. For this task the following procedure is applied:

1. In a first model run, underlying the assumption of the implementation of all projects i on corridor j, all relations are stored, which are routed via the specific project i being part of corridor j. This results in a set of project-specific O/D relations, which are routed via the specific project.
2. A routine identifies all project-specific O/D flows from step 1 on the other networks for the situation that corridor j is implemented, as well as for all assigned traffic flows in the reference situation.
3. With all transport flows relevant for the project under consideration being identified, both for the situation “with” the project and the reference situation “without” it, the dimension of impacts caused by all transport flows concerned by the project, can be measured.

This approach is visualised by Figure 6.

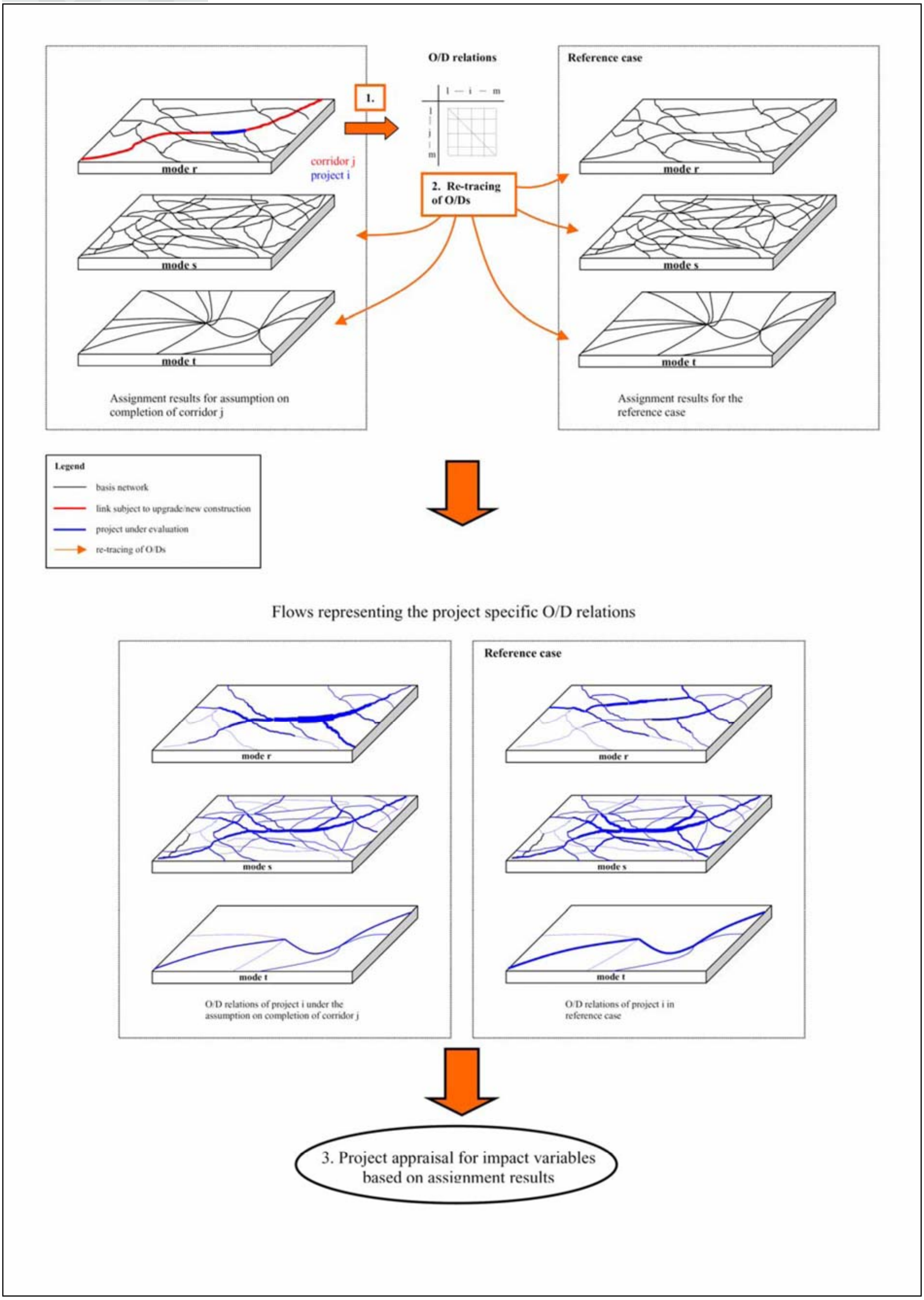


Figure 6: Organisation of generation of performance data for impact criteria based on transport flows in the whole transport system

The approach for generation of performance data for impact variables based on transport flows in the whole transport system as described above implies the possibility of double counting: If a certain O/D pair tackles more than one project of a corridor, the problem of double counting arises, with the O/D, their routing through the network and the subsequent assessment being analysed for each project individually. In order to overcome this problem the project-specific assessment is combined with a corridor assessment:
The corrected performance index for project i on corridor j, $(X_i)'$, is calculated as follows:

$$(X_i)' = \frac{X_i}{\sum_i X_i} \cdot X_j \qquad ,$$

with

X_i performance value of impact variable X for project i, belonging to corridor j
X_j performance value of impact variable X for corridor j

The project-specific estimation of impacts on emissions of CO_2, NO_X and particulates relates to the third category of impact criteria. Since the estimation of emissions are based on assignment results, which have been generated for each corridor, the results generated at corridor level have to be translated to the project level, for which the approach on selection of relevant O/Ds on a project is applied.

The changes in emission volumes of emission gases e assigned to project i, CEV_i, are calculated as follows:

$$CEV_i^e = \sum_m (EV_m^{ref})_i^e - \sum_m (EV_m^j)_i^e$$

where

$(EV_m^{ref})_i^e$ emission volume of emission gas e, by mode m, caused by all traffic O/D flows, whose path is routed via project i, under the transport infrastructure assumptions of the reference networks

$(EV_m^c)_i^e$ emission volume of emission gas e, by mode m, caused by all traffic O/D flows, whose path is routed via project i on corridor j, under the assumption that all sections on corridor j are realised

In order to avoid double counting the corrected changes in emissions assigned to project i, $(CEV_i^e)^{corr}$, are estimated according to following formula:

$$(CEV_i^e)^{corr} = \frac{CEV_i^e}{\sum_{i(i \in j)} CEV_i^e} \cdot CEV_j^e \quad \text{,with} \quad CEV_j^e = \sum_m (EV_m^{ref})^e - \sum_m (EV_m^j)^e$$

where

$(EV_m^{ref})_i^e$ emission volume of emission gas e, by mode m, caused by all traffic flows, under the transport infrastructure assumptions of the reference networks

$(EV_m^c)_i^e$ emission volume of emission gas e, by mode m, caused by all traffic flows, under the assumption that additionally to the assumptions of the reference scenario all sections on corridor j are realised

3.4.4. Impact criteria independent from modelling results

Performance data for impact criteria independent from modelling results, like qualitative appraisal of a project's contribution for an intermodal transport system or appraisal of the project planning status, are generated by expert judgements. The expert judgements are largely based on further available information on the projects from different sources, mainly from European or national level.

3.5. From the European to the local level – integration of the local dimension

Although the view of the Strategic Assessment Framework has clearly a European scope, the approach intends not to neglect the local dimension, whose consideration is crucial for environmental criteria or the criterion related to road congestion. For instance, the local dimension is considered by following two approaches:

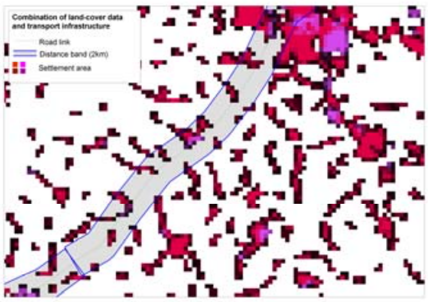
- For selected agglomeration areas along corridors passenger demand matrices at NUTS 5 level have been estimated and considered for assignment.
- Land-cover data has been applied for environmental criteria.

The methodology of the latter approach is dealt with in the present paragraph. The main task of the impact criterion "Level of concern – emissions by the road mode" is to represent a measurement of inhabitants' level of concern caused by emissions of air pollutants of the road mode. For this task information of the CORINE[9] land cover database is joined with data on number of inhabitants at regional level, in order to be able to assign certain numbers of inhabitants to grids covered by settlement areas. Figure 7 illustrates this approach by showing a 2000-metres distance band along a road link being crossed with settlement areas. With the population spatially distributed to grids the information on spatial vicinity of road links to inhabitants can be measured, and – by taking into account characteristics of spreading of air emissions by the road mode in the space – a risk matrix for exposure of inhabitants to road traffic emissions can be developed (see Table 3).

Table 3: Risk matrix for exposure of inhabitants to road traffic emissions

Risk class	**Distance from the road link**	**Weight (w)**
1	500 metres and less	20
2	500 – 1000 metres	2
3	1000 – 2000 metres	1

Figure 7: Crossing of road infrastructure with settlement areas



With this methodology, the change in level of concern caused by project i, CLC_i, is calculated as follows:

$$CLC_i = \sum_l \sum_k w_k \cdot I_{k,l} \cdot (EL_l^w)^i - \sum_l \sum_k w_k \cdot I_{k,l} \cdot (EL_l^{ref})^i$$

where

$(EV_l^{ref})^i$ emission volume of road particulates on link l, caused by all traffic O/D

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[9] CORINE: Co-ordination on Information of the Environment

	flows, whose path is routed via project i, under the transport infrastructure assumptions of the reference networks
$(EV_l^w)^i$	emission volume of road particulates on link l, caused by all traffic O/D flows, whose path is routed via project i, under the assumption that all sections on corridor j are realised
w_k	level-of-concern weight associated with distance class k
$I_{k,l}$	number of inhabitants along road link l in distance class k

For avoiding double counting the same approach as in section 3.4.3 is applied.

3.6. Methodology for transferring performance data to scores

After a generation of the performance data at a wide range of different scales the performance data are transferred to a common scale. Following the TENASSESS[10] approach, the performance value for each indicator is normalised using a scale between –5 and +5 (only unitary values are used). The minimum/ maximum values of such measure relate to a very negative/ very positive performance of the project in achieving the corresponding objective.
The normalization approach of performance data for attaining a common scale is done for each criterion individually, depending on the unit of measurement and the metric scale of the impact criterion. The methodology for generating a common scale for the performance values is illustrated by following two examples:
Several criteria are measured at a ratio scale: For instance, the criterion “Changes in time costs caused by road congestion” is measured in absolute values and displays the difference in transport time costs due to road congestion with the project and without the project.
If p_{ij} measures the performance of project i for criterion j, with j being related to ratio scale, then $\hat{p}_{ij}$ – the standardized performance value of project i for criterion j – is defined as follows:

$$\hat{p}_{ij} = \begin{cases} 5, & if \quad \max_i(p_{ij}) \le p_{ij} < \tfrac{4}{5}\max_i(p_{ij}) \\ 4, & if \quad \tfrac{4}{5}\max_i(p_{ij}) \le p_{ij} < \tfrac{3}{5}\max_i(p_{ij}) \\ 3, & if \quad \tfrac{3}{5}\max_i(p_{ij}) \le p_{ij} < \tfrac{2}{5}\max_i(p_{ij}) \\ 2, & if \quad \tfrac{2}{5}\max_i(p_{ij}) \le p_{ij} < \tfrac{1}{5}\max_i(p_{ij}) \\ 1, & if \quad \tfrac{1}{5}\max_i(p_{ij}) \le p_{ij} < 0 \\ 0, & if \quad p_{ij} = 0 \\ -1, & if \quad 0 \le p_{ij} < -\tfrac{1}{5}\max_i(p_{ij}) \\ -2, & if \quad -\tfrac{1}{5}\max_i(p_{ij}) \le p_{ij} < -\tfrac{2}{5}\max_i(p_{ij}) \\ -3, & if \quad -\tfrac{2}{5}\max_i(p_{ij}) \le p_{ij} < -\tfrac{3}{5}\max_i(p_{ij}) \\ -4, & if \quad -\tfrac{3}{5}\max_i(p_{ij}) \le p_{ij} < -\tfrac{4}{5}\max_i(p_{ij}) \\ -5, & if \quad -\tfrac{4}{5}\max_i(p_{ij}) \le p_{ij} < -\max_i(p_{ij}) \end{cases}$$

with
$\max_i(p_{ij})$ representing the best performance value for criterion j (which, if j represents a reduction of costs or emissions, is the highest negative score). Depending on the characteristics and variation of performance results for a certain impact criterion, the threshold for the minimum or maximum score is slightly lowered or elevated.

[10] Halcrow Fox, Deliverable 4: The TENASSESS policy assessment methodology (PAM), TENASSESS project, 4th EC RTD Framework Program, 1997

Other criteria are measured at ordinal scale and are based on a qualitative assessment, like the impact criterion "Qualitative appraisal of the project's contribution for an intermodal transport system".

For this example the standardised performance value, $\hat{p}_{ij}$, is defined as follows:

$$\hat{p}_{ij} = \begin{cases} 5, & \text{if the project creates intermodal connection with other long-distance transport modes} \\ 2, & \text{if the project creates intermodal connections with urban/ local networks} \\ 0, & \text{if the project does not have any effect on intermodality} \\ -2, & \text{if the project reduces intermodal interfaces on urban/ local networks} \\ -5, & \text{if the project reduces intermodal interfaces between long-distance modes} \end{cases}$$

With all data in the performance matrix being available at a common scale, and presuming the availability of weights for each evaluation criteria, a ranking of the projects can be made.

4. Summary and conclusions

The pictured methodology for the Strategic Assessment Framework has proven its capability of assessing large-scale transport infrastructure projects on corridors. The results reflect the projects' performance for the assessment criteria and give an indication of a project`s performance regarding

- reduction of congestion and bottlenecks,
- creation of European value added,
- financial, economic and environmental sustainability,
- improvement of regional centrality,
- its general transport relevance,
- and its maturity and coherence of its planning status.

The perception of the infrastructure projects as being components of transport corridors is inherent to the methodology depicted. The generation of the performance data for several of the impact criteria relies on results of two European network-based transport models for passenger and freight transport and is supported by tools, which allow a further analysis of impedance matrices and assignment results.

Based on the contents of the performance matrix generated by the methodology described in the present paper, the results can be processed further and be used for a ranking of the projects. This implies the requirement of attaching weights to each criterion, a task for which special attention has to be paid, for instance, in order to avoid double counting.

The effects of indicators based on assignment results tend to be over-estimated, since in the reference case a less ambitious infrastructure situation is assumed, which excludes the possibility of a simultaneous realisation of (potentially competitive) priority corridors and projects. This issue has been overcome by generating the performance data additionally for a situation, in which not only one priority corridor is assumed of being completed, but the whole set of EU priority corridors.

Although the pictured Strategic Assessment Framework integrates the local dimension of impacts – e.g. by taking into account local passenger traffic flows and using land cover data –, the local dimension is still considered from a European perspective. This implies that specific regional and local peculiarities, like specific traffic situations during rush hours, have not been taken into account. A further difficulty has been the heterogeneity of information being available for the projects: For some infrastructure projects, especially for those projects having been in the scope of EU priority projects since 1996, all required information is available, whereas for other projects not even the geographical alignment of a new line is known (e.g. for the new high-speed link between Madrid and Lisbon or the new high-capacity rail link across the Pyrenees).

Summarising, the Strategic Assessment Framework, by taking into account both the European and the local dimension of assessing transport infrastructure projects on corridors, has turned out to be a suitable instrument for project assessment from an international, European perspective. However, it does not replace further, more detailed project/ corridor studies, in which local peculiarities can be dealt with in a most appropriate way.

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