TRANS-EUROPEAN PERFORMANCE-BASED TRANSPORT PLANNING

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Abstract

The requirements and demands of the Trans-European transport network (TEN-T) to improve mobility, safety and productivity are becoming increasingly significant in European countries, but also at the same time more expensive and increasingly challenged. Out of around € 80 billion invested per year in Europe for transport infrastructure, only € 20 billion go toward TEN-T network development. This has been coupled with excessive distortions in modal growth and travel demand shares. Such an imbalance causes Europe to suffer from congestion, accidents, and harmful effects on the environment and health. On top of that, enlargement of the European Union brings to light the need for accessibility and development of priority infrastructure for candidate countries. The paper presents the work and final results of the project, INDICATORS, commissioned by the European Commission to specify a consistent and permanent **performance monitoring mechanism** to evaluate the Trans-European infrastructure and traffic. The research conducted a comprehensive European-wide survey aimed at understanding requirements and perspectives on the development and application of performance indicators at the national strategic levels. For each defined objective, a concise set of performance indicators are elaborated in measurable standard terms, for use at a network scale to evaluate and monitor the performance of the multi-modal TEN-T network. The paper concludes with recommendations for the implementation and adoption of the developed performance-based framework.

Keywords: Performance indicators; European policy; Transport network
Topic Area: E2 Performance Measurement

1. Introduction

The European Commission is engaged on a bold and long-term mission to improve the **Trans-European Transport Network (TEN-T)** so that it operates in an efficient and seamless manner, irrespective of location. In July 1996, the European Parliament and Council adopted **Decision N° 1692/96/EC** on Community guidelines for the development of the trans-European transport network (CEC, 1996). These guidelines comprise roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems which serve the entire continent, carry the bulk of the long distance traffic and bring the geographical and economic regions of the Union closer together. In May 2001, the European Parliament and the Council adopted **Decision N° 1346/2001/EC** as an amendment to the TEN-T guidelines regarding seaports, inland ports and intermodal terminals (CEC, 2001a). In the TEN-T guidelines, emphasis is made on cross-border and network connectivity, encouraging non-road modes for passenger and freight traffic and ensuring accessibility and interoperability across the network. The current TEN-T network contains 75200 km of roads, 78000 km of rail tracks, 330 airports, 270 international sea ports, 210 inland ports.

A recent High-Level European Group on TEN-T, mandated by the Commission to assess and identify the priority projects of the trans-European transport network up to 2020 on the basis of proposals from the Member States and the acceding countries on the development of the TEN-T network, found that the amount of progress is not keeping up to the objectives envisioned in 1996 to complete the network by 2020 (CEC, 2003b). The network is characterised by a worrying increase in congestion, due to the persistence of bottlenecks and of many cross-border missing links and a lack of interoperability. The prospect of enlargement to include 12 new countries in the EU accentuates the need for a new approach to preserve the competitiveness of the European economy and to guarantee a balanced and sustainable development of transport. The Member States are currently investing less than 1% of their gross domestic product in building transport infrastructure and devoting only one third of this investment to achieving the trans-European network. The Group considers that the latter is currently suffering from under-investment, which may prevent a fair number of the network projects, notably some priority projects, to be completed within the desired time frames, despite their positive repercussions on the entire economy of the Union. A recent project to asses the level of investment on the TEN-T confirms these findings (Planco, 2003)

In view of the delays in completing the planned network, the European Commission wishes to revise the guidelines. The revision should focus Community activities and projects on reducing the bottlenecks on major routes and on a small number of priority projects. Against this background the Commission proposed in October 2001and in 2003 a limited revision for the TEN-T guidelines to tackle the new challenges facing transport and to help to meet the objectives of the new transport policy, as described in the White Paper on a common transport policy for 2010 (CEC 2001b, CEC, 2003a). It aims at reducing the bottlenecks in the planned or existing network without adding new infrastructure routes by **concentrating investments** on a few horizontal priorities and a limited number of new specific projects. The intention of the Commission is to revise the TEN-T Guidelines more fundamentally in 2004, to take account of Enlargement and expected changes in traffic flows and in light of the findings of the High-Level TEN-T Group (CEC, 2003b). New outline plans for the period 2020-2025 will be drawn up to concentrate on a primary network made up of the most important infrastructure for international traffic and cohesion on the European continent.

Critical to the co-ordinating and promoting role is knowledge of the **performance of the TEN-T network** (Turro, 1999; CEC, 2000b). At the trans-European level this translates into examination of all the effects of investing in and using the network in relation to policy objectives, in order to monitor the guidelines related to the TEN-T. On the other hand, Member States maintain national statistical databases to monitor the implementation of transport infrastructure and monitor the progress of their national Transport Masterplans. Levels of network detail and scope vary with the transport context and policy priorities of each country.

The central issue is to develop a **consistent performance-based framework** that will provide a cost effective (and acceptable) basis upon which to measure **policy measure effectiveness** at a trans-European network level. What is needed at a European level is a **concise set of indicators**, (in measurable standard terms), that can be used at a "network element" scale.

On that basis and within the framework of the European Union TEN-T activity, the European Commission's Directorate-General for Energy and Transport (DG TREN) initiated the **"INDICATORS"** project (TRL et al., 2002). This project included partners

from four EU countries**:** TRL (United Kingdom) as project co-ordinator, Dorsch Consult (Germany), DHV Environment and Infrastructure (the Netherlands), and ISIS (France).
The opinion and conclusions expressed or implied in this paper are those of the author. They are not necessarily those of the European Commission or any other national or European entity

2. Objectives

The overall objective of the research is to specify a consistent and permanent indicators-based **monitoring mechanism** to evaluate the Trans-European infrastructure and traffic taking into account national and European technical, institutional, legal and contractual aspects.

A concise set of indicators should evaluate and monitor the performance of the TEN-T network and provide adequate support for **informed decision-making** towards achieving specific **goals and targets** for the various transport modes and sectors. Such a performance framework must reflect trans-European transport policy objectives in terms of **regional development** and **accessibility**, as well as other factors such as **mobility**, **modal balance**, **environment**, **safety**, **interoperability** and **intermodality** at the **network** link and node levels.

3. Scope of performance indicators

In keeping with the role of the EU and the Community guidelines and priorities for development of the Trans-European Network, the performance indicators in this research serve in the following specific domains for strategic infrastructure planning and evaluation:

- **Network monitoring** (monitoring the implementation of the guidelines, including development of the TEN-T network, safety, mobility, and environmental impacts)
- **Network planning** (revision of the trans-European guidelines to reflect evolving priorities and needs)

The performance indicators surveyed and developed cover the following application contexts:

- **Sector:** Passenger, Freight
- **Mode:** Road (car, bus, truck), Rail, Airports, Inland waterways, Seaports; Intermodal aspects
- **Area:** National transport network and links forming part of the Trans-European transport network including networks for Candidate Countries for Accession.

Performance indicators identified are quantifiable at the **spatial transport network level** of **corridors**, **main sections** (links), and **nodes** (terminals) on the TEN-T network. Global and regional data are only used in the context of weighing or adjusting the indicators to clearly reflect the variety of transport environments.

4. Project approach

The indicators proposed by the research refer to the implementation, at the network level, of the EC Decision 1692/96/EC -TEN-T guidelines and the amendments and proposed revisions (CEC, 1996; CEC, 2001; CEC, 2003a), taking into account national and European resources and constraints in data collection.

As seen in Figure 1, the approach incorporates the following 5 integrated tasks:

- Task 1: Data Collection and design of monitoring framework to measure the performance of individual projects, corridors, infrastructure programmes or the network based upon consultations with Member States and European organisations.
- Task 2: Detailed classification, assessment, selection and validation of indicators:
- Task 3: Assessment of the indicators' usefulness by means of case studies.
- Task 4: Study of the operational and organisational aspects of the functioning and administration of the proposed monitoring system within the European Commission,
- Task 5: Refinement of the list of indicators and to set out final recommendations in view of the establishment of the TEN-T performance monitoring system.

5. Translating European goals into indicators

Performance indicators need to reflect European policy objectives in measurable terms to provide relevant criteria to monitor and measures the performance of the TEN-T. The development of goals and objectives is one of the most time-consuming of processes. Added to that, the process of defining '*trans-European*' goals that directly relate to European priorities including those of Member States, then the process becomes extremely difficult and time-consuming, requiring a broad consensus.

Although, most national and European authorities have already developed goals for their planning activities through national Guidelines and Master Plans, performance indicators require transport authorities to sometimes take a closer look and refine (or clarify) their goals into a more quantitative and methodical process. This would make them more operational in terms of monitoring, planning, and funding as well as providing a relevant context for developing performance indicators.

The task of the research has been to work in the linking of goals and objectives to the process of developing relevant performance indicators. The definitions of '**goals**' and '**objectives**', as well as the terminology used to describe them (such as 'policies', 'priorities', strategies' and 'recommendations') vary widely across Europe and usually not clearly defined in measurable terms.

Recognising the differences in transport policy objectives and priorities between Member States due to different environmental, population, and socio-economic contexts, no particular priority is given to certain goals or corresponding objectives. On the basis of discussions with Member states, candidate countries and the European Commission, the objectives proposed have been classified into eight categories according to the following trans-European policy **themes**:

- Mobility,
- Accessibility,
- Optimal use of capacities,
- Safety,
- Intermodality and interoperability,
- Economic viability ,
- Environment,
- Modal balance.

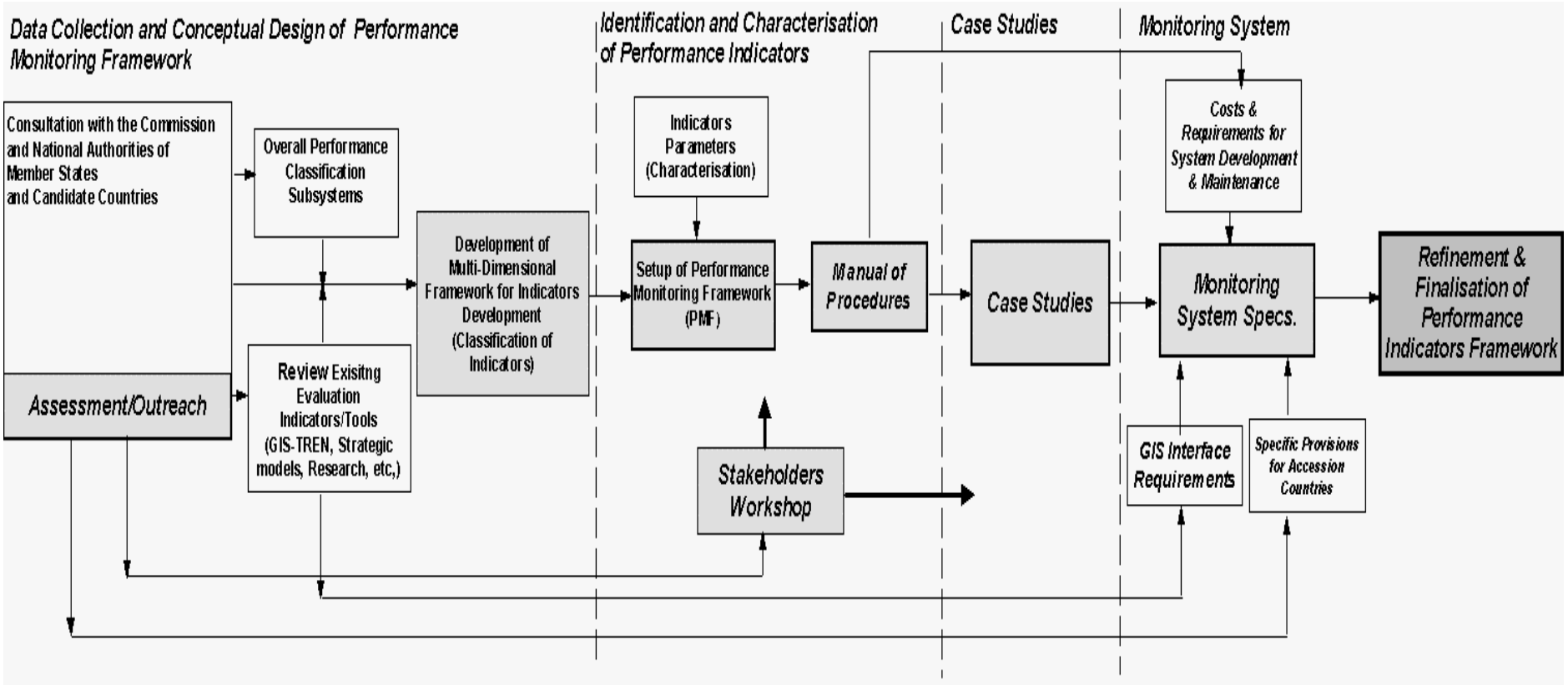


Figure1: Work Approach

Based upon the material collected from the European Commission and Member State authorities and based upon international standards for indicators development, in particular the research project undertaken by the National Co-operative Highway Research Program (NCHRP) in the US for developing guidelines for performance-based transportation planning (Cambridge Systematics, 2000), the research undertook a pragmatic approach to develop and continuously refine a typology of goals and objectives, establishing relationships between the goals, objectives, and measurements of transportation system performance (see Figure 2).

The purpose of the typology is to clarify how the selection of appropriate performance measures is a function of the particular goals and objectives, and furthermore, how the data needs are in turn driven by the goals, objectives, and measures. The linkages between these elements of the process, and the feedback loops integrated into the process, are the defining features of a performance-based planning process. The objectives should not be seen as final, but as **illustration** of how performance-based planning can translate general European policy goals into specific indicator measures to monitor and plan the Trans-European Network.

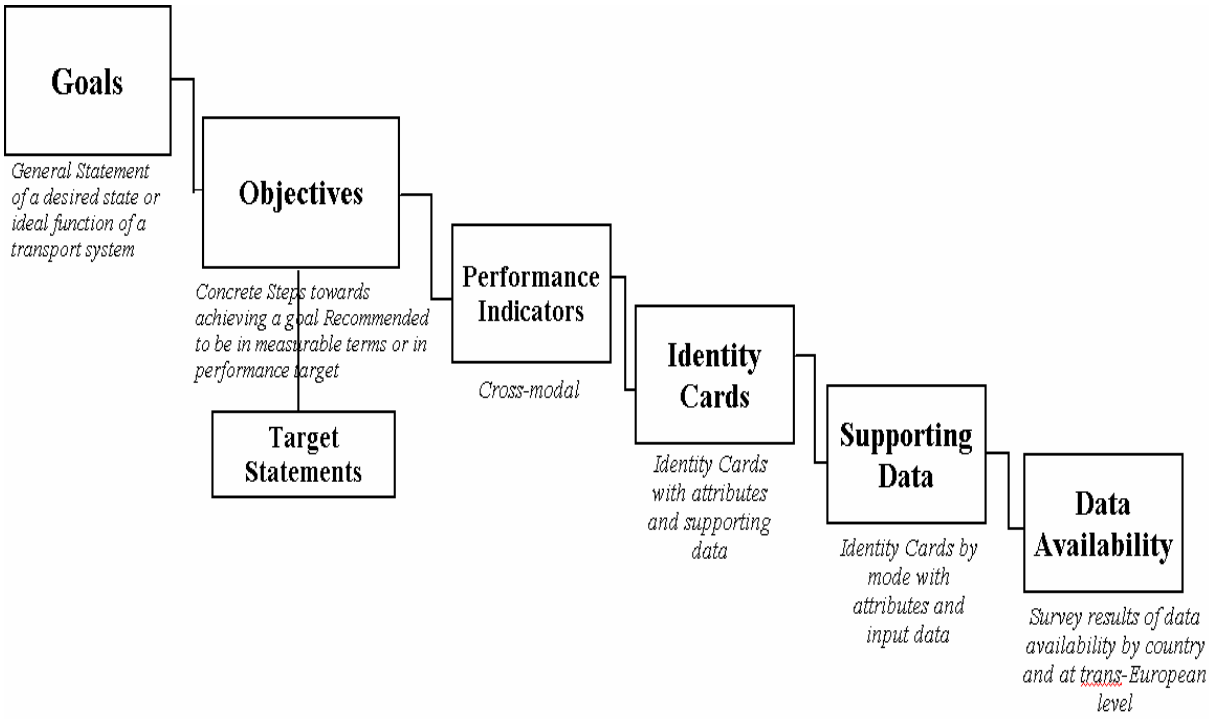


Figure 2: Typology of Goals-Objectives-Performance Indicators

The two main principles at stake are **usefulness of the indicators** for TEN-T monitoring (primarily to the EC, but also to other bodies at a European and national level in relation with transport policies) and the **speed and ease of which they can be implemented** (by national or regional authorities).

Thus it was essential to derive indicators using a combination of a **top-down process** (what are the policy goals at European level, what needs to be measured?) and a **bottom-up process** (what data is already collected in each country, how homogenous and statistically-robust is this data, can new indicators be implemented speedily and cost-effectively?)

For these reasons, the long “wish list” needed to be reduced to a set of indicators which:

- are relevant to TEN-T goals and focused on objectives;
- are robust and well defined;
- have data readily available at national level;
- are useable and implementable in a short time-scale;
- are cost-effective;
- are comparable (between countries and, where possible, between transport modes);
- can be used to measure progress towards defined targets or measure quality against defined benchmarks; and,
- can be integrated into regular procedures

6. Review and consultations

The bottom-up approach has demonstrated pragmatism by including research into existing data sources and survey of availability at European level. To this end, a **review of studies** pertaining to performance indicators and strategic transport policies and priorities at the European, national, and international levels was made (OECD, 1997; OECD, 2001; EEA, 2000; EEA, 2002; Cambridge Systematics, 2000).

A review of previous studies and practices revealed that in most cases, with the exception of traffic demand and investment data, performance indicators are estimated and monitored at a **global strategic** level. Under a national US research project that started in 1994 and ended in 2000, the objective was to develop a framework for performance-based transportation planning (Cambridge Systematics, 2000). The case studies and data collection was conducted at the US state and regional agency levels across all modes: road, rail, air and water. The results of the study should be viewed only as reflecting the perspective of US transportation agencies and case studies. However, some aspects pertinent to the European environment as cross-border criteria, interoperability and multiplicity of funding agencies could be useful in European-related effort. At the US federal level, since 1999, the US DOT produces an annual performance report detailing the performance of the national transport system in meeting strategic goals and objectives as safety, mobility, and environment (US DOT, 2001). In 1997, the OECD carried out a study to examine current practice in evaluation of the effectiveness of road administrations (OECD, 1997). On the basis of OECD national experts, 16 global indicators, that are frequently used, were identified as the minimum required for the effective measurement of road performance from the user and road administration perspectives. A similar study, sponsored by PIARC (PIARC, 1999), provided 3 categories of indicators based upon consultations with experts from the PIARC Groups: indicators of the quality of the road, indicators of service quality associated with the intrinsic quality of the road (ancillary services associated with the basic road function, maintenance service, operating service) and indicators of the overall service quality.

In addition, **consultation** was undertaken with DG TREN and other organisations, including Eursotat, UN/ECE, UIC, and WERD[1], to define the priorities and plans for the TEN-T guidelines revision and to assess their opinion regarding factors and indicators used for project appraisal and selection. In particular, Eurostat, being the statistical arm of the Commission, provided valuable input regarding their data collection practices in response to various current and proposed EU Directives and voluntary exercises and their plans for development, in view of the inputs from the Member States. For **road, rail** and **inland waterways**, the current European Directives do not provide flow statistics at the network

[1] See glossary of terms at the end of the paper

level. Data are collected at the national or regional levels. Some Directives are currently under preparation for data collection at the link level, in particular rail (COM (2000) 798). An in-depth review of the resources for performance indicators revealed that the majority of data collection exercises were directed at the global or regional scale, without reference to the network or link level. Traffic volume and some infrastructure data at the link level was an exception with the UIC Rail Database (UIC, 1999), UN/ECE Road Census (UN/ECE, 2002) and the national traffic censuses for the transport network providing data, albeit not covering the whole TEN-T network. Other transport data at the link or node network level are hard to find in a consistent harmonised form.

National questionnaire survey

The largest part of the consultation and data gathering exercise was the development of a questionnaire survey for the EU Member States, EFTA countries and Candidate Countries for EU Accession. The questionnaire aimed to provide the project team with an.

A **national EC questionnaire** of all 15 EU Member States, together with EFTA countries and Candidate Countries for Accession was conducted. These responses allowed the project team to determine the different national perspectives on the development and application of performance indicators/statistics at a strategic national level:

- what data is currently collected and what time and space scales;
- what indicators are currently or potentially used;
- how relevant the national administrations consider various indicators to be trans-European relevant.

The survey revealed that in many cases, the availability of statistical data is currently an impediment. Data, when available, did not largely comply with certain quality standards, e.g. the need to be precise, comparable, and as recent as possible. Data are often only available at the aggregate countrywide level through the efforts of organisations such as Eurostat, UN-ECE, and ECMT. Data at the network level is very limited, particularly in case of sectors undergoing liberalisation and deregulation of transport. Breaks in time series and data quality limit the possibility for performance analysis over time. Definitions and scope of data vary between countries, and also within countries (between different regions and between different private infrastructure operators). More details on a country-by-country result can be found in the INDICATORS Final Report (TRL et al., 2002)

On the basis of the survey and according to the application scope identified, indicators and supporting data classes receiving the highest scores among national authorities and the Commission in terms of data availability, measurability, and trans-European relevance were compiled for use at the trans-European level. Table 1 lists the various data categories/statistics (by mode) and for each one provides a priority level.

[A]: Data Category is directly relevant to trans-European Objectives, and therefore should be adopted at the TEN-T level.

[B]: Data Category is not immediately relevant, but should be considered for potential adoption in the longer term.

The table also summarises the likely data availability at national level. Since specific information on level of data availability was not collected in the study, this information is based on responses given in the survey of the levels of use of the different indicators. The classifications used below are:

[1]: Data is generally readily available at the national level for almost all countries.

[2]: Data is available for some countries, or is partly available at the national level (e.g. possibly in a non-standardised form).

[3]: Data is generally not available for most countries, or very difficult to obtain.

Table 1: Trans-European Relevance and Likely Availability of Various Data Classes

Mode	Data Category	Trans-European Relevance[2]	National Data Availability[3]
Road	Size of road network	A	1
	Road traffic demand	A	2
	Road capacity	A	2
	Road traffic safety	A	2
	Road network safety	B	2
	Road energy consumption	A	2-3
	Road transport emissions	A	2
	Road transport noise	B	2-3
	Investment in road infrastructure	A	1
	Investment in road telematics	B	2
	Road freight transport	A	3
Rail	Size of rail network	A	1
	Rail traffic demand	A	2
	Rail capacity	A	3
	Rail interoperability	A	1
	Rail safety	A	1-2
	Rail energy consumption	B	3
	Rail transport emissions	B	2-3
	Rail transport noise	B	2-3
	Investment in rail infrastructure	A	1
	Rail freight transport	A	2
Air Transport	National airport capacity	A	1
	Level of utilisation of airport capacity	B	1-2
	Capital investment in airports	A	1
	Investment in air traffic control operation	A	1
	Airport Revenue and profit	B	1
	Return on capital employed for airports	B	1
	Air transport emissions at airports	B	2-3
	Air transport noise	A	2
nd wate rwa	Size of inland waterway TEN-T network	A	1
	Inland waterway freight demand	A	2

[2] [A]: Data Category is directly relevant to trans-European Objectives; [B]: Data Category is not immediately relevant.

[3] [1]: High; [2]: Medium; [3] Low Availability

Mode	Data Category	Trans-European Relevance[2]	National Data Availability[3]
	Waterway capacity	A	2-3
	Waterway availability	A	1
	Energy consumption for inland waterways	B	2-3
	Transport emissions for inland waterways	B	2-3
	Investment in inland waterways	A	1
Seaports	Seaport demand	A	2
	Seaport capacity	A	3
	Seaport availability	B	1
	Investment in seaports	A	1
Inter-modal	Terminal utilisation	A	3
	Terminal capacity	A	3

A key link between the national governments and the EC is the **TEN-T Committee**, an EU body composed of a representative from each Member State with observers from the Accession countries, with the mission to monitor, refine and validate EU transport policy, priorities and implementation on the Trans-European Transport Networks (all modes).

The European Commission (DG TREN) held a Performance Indicators Workshop in 2001 with the purpose of presenting the draft list of indicators and discussing these, together with other TEN-T performance monitoring issues. This was an important part of the performance indicators' validation process and considerable feedback was received. The key stakeholders taking part in the workshop were the national authorities (transport departments of the EU Member States, EFTA and Accession Countries), the European Commission (DG TREN) and invited European institutions and organisations. Recommendations for the gradual adoption and development of the reporting framework take into consideration the various constraints available and the evolving needs. Specific provisions for Accession Countries were also recognised.

As necessary tools for computerised monitoring and performance analysis of the TEN-T network, the research also conducted a technical audit of the available database tools and models available in DG TREN including the GIS database tool currently in use in DG TREN and provided recommendations on how to upgrade and develop the tools for efficient network performance assessment and monitoring, in line with the framework proposed.

7. Key results

The current **Infrastructure Reporting mechanism** to report on the status of the TEN-T network forms the starting point for development of a full-scale **monitoring mechanism** (CEC, 1998). Member States are required to regularly notify the Commission of the national plans and programmes which they have drawn up for the development of the TEN-T network. Basic infrastructure data, currently collected, through biannual surveys of Member States can be expanded to include data required for the estimation of Performance indicators required for a better picture and assessment of the TEN-T and the degree of achievement of trans-European objectives and priorities. The use of performance indicators would provide needed depth to assess investment priorities and gaps in the network. In the

particular case of the interim TEN-T guidelines currently being reviewed and the new TEN-T guidelines expected to come out in 2004, the need is greater for a consistent reporting and monitoring mechanism for the TEN-T.

The project confirmed that **collecting and maintaining data** to support performance-based planning programs in Europe is a critical obstacle. The vast majority of national transport authorities surveyed indicated that their data collection resources are limited. In the area of freight movements, these constraints are even more apparent. Freight shipments are more varied in content, and vary more over time, than passenger movements, so accurate data collection is a complex, costly process. Co-operation from the private sector or operators in various modes is sometimes limited due in part to concerns about competitiveness and security reasons.

Key issues facing Candidate Countries for Accession include the environment, financing of the transport sector, recent organisational restructuring of the transport sectors (especially the railways) and the rapidly decreasing share of environmentally friendly modes of transport. The restructuring of the transport sectors in most Candidate Countries for Accession seems to lag behind the development of the transport sector in EU countries. Thus, these countries have an even greater need for a more precise definition of transport networks and performance targets at the short- and long-term scales so that scarce funding should be used as efficiently as possible.

In the short-term, infrastructure investments to extend and improve the quality of the networks in the Accession Countries are a key priority. Total investment needed to maintain and develop the transport system infrastructure to EU standards is at least €90 billion. More than half of the amount is foreseen for road networks, and around €30 billion for the rail network. In the longer term, the Commission has estimated that €258 billion would be needed to enhance transport networks to acceptable standards.

Table 2 outlines specific performance indicators developed in response to the European policy goals and objectives and applicability based upon data availability at the national and trans-European levels. In the long-term, these objectives should be based upon a consensus process by all Member States with the European Commission to specify a common set of specific measurable objectives that can be used in a 'European Transport Master Plan'. Indicators are classified as being applicable in the **short-term** prior to in the context of the 1998-2003 TEN-T implementation and **long-term** following major revision of the TEN-T guidelines in 2004. The objectives shown are meant to provide guidance on typical specific objectives relevant to the TEN-T policy goal statements outlined in the previous section. These objectives are by no means official and reflect only the views of the researcher. For more details and in-depth review of each indicator in terms of units, relevance, supporting data, and spatial resolution (link, corridor, terminal, and network), the reader should refer to Final INDICATORS Project Report (TRL et al., 2002). Indicators are seen as being **infrastructure-related** concerning network suppliers and **service-related** where the performance of the network is affected by the quality of services and operations. In many cases, deficiencies cannot be corrected by infrastructure investment policies such as the TEN-T guidelines, but also by regulatory measures and efficient operation of the network.

Table 2: Overview of Key Indicators

	Objective	Performance Indicator	Description	Applicability*
Mobility	1. Improve Level of Service on TEN Infrastructure	- Weighted Level of Service Index	Level of service for TEN links and nodes comprising a composite index of volumes, capacities, speeds, travel time, delays, and service frequency.	Long-term requiring harmonisation and accepted set of threshold standards
	2. Eliminate bottlenecks Optimise capacity on existing infrastructure	- Actual Demand/Capacity (%) for each mode - Days per year where capacity limits are exceeded	Capacity utilisation for each mode Proportion of time TEN link or node has a traffic demand close to design capacity	Short-term
	3. Optimise modal split along international corridors for road and rail	- Actual Demand/Capacity (%) for road and rail on corridors - % of passenger and freight traffic by road and rail per major corridor	Comparison of capacity utilisation across modes for each corridor Freight and passenger modal split for each corridor	Short-term (but % of traffic per major corridor may be long term, as additional data collection is needed)
	4. Ensure infrastructure investment according to trans-European guidelines	- €/section and km completed on the TEN-T links	Level of investment on the TEN-T network	Short-term
	5. Reduce cross-border delays for rail transport	- Average minutes/equivalent transport unit (split by passenger and freight rail traffic)	Traffic demand and waiting time for rail at border stations / freight yards.	Short-term

* Short-term before 2004 as part of implementation monitoring with existing TEN-T guidelines and after standardisation. Long-term after revision of TEN-T guidelines in 2004 requiring additional data collection and harmonisation efforts.

	Objective	Performance Indicator	Description	Applicability*
Optimal Use of Capacities	6. Encourage use of TEN-T as major corridors for long-distance and international traffic	- Long distance international traffic units/Total traffic units on network	Proportion of traffic making journeys over a threshold distance (e.g. 200 km) on the TEN-T	Long-term, requires detailed surveys
	7. Seaports shall promote short sea and international shipping	- Equivalent transport unit (etu) by shipping type - Number of operating days per year due to climate, strikes, etc., - Demand/capacity measures for road and rail links to seaport	Utilisation of seaports Availability of seaports Quality of surface connections to seaports For seaports of Category A and B only (as defined in the TEN-T Guidelines)	Short-term
	8. Enhance the use of ITS on the TEN-T	- €/km by key ITS service - % of network covered by ITS services	Annual ITS Investment on TEN links Availability and coverage of key ITS services on TEN-T	Short-term
Safety	9. Reduce the number of accidents	- Accidents/traffic units (billion vehicle-km) on TEN per year	Accident rate of agreed category on TEN- reduction target	Short-term for roads, long-term for other modes
	10. Reduce the number of accident black spots on the overall network	- Number of black spots per 1000 km of TERN[4]	Number of locations (either single points or stretches of network up to 1 km) on TERN where target number of repeated accidents occur	Long-term

[4] TERN: Trans-European Road Network

	Objective	Performance Indicator	Description	Applicability*
Intermodality / Interoperability	11. Encourage unitisation and containerisation of freight	- % of container traffic/total freight	Proportion of freight that is unitised (containers, swap-bodies, piggyback) on TEN	Short-term
	12. Reduce door-to-door transit times for freight	- Mean commercial speed for containerised/unitised goods (km/h) per corridor or major O-D pair	Overall freight transit times between origin and destination terminals divided by distance on TEN	Long-term
	13. Improve accessibility to the intermodal transport system	- Number of interchanges/km or number per capita for rail - Tonne-km at interchange	Increase in number/utilisation of inter-modal interchanges per km	Short-term
	14. Increase terminal utilisation	- % increase in throughput over the previous year	Throughput in transport units transferred (a unit being a vehicle or a container)	Short-term
	15. Promote passenger multimodality	- % of multimodal travel on the TEN-T	Proportion of multimodal ticketing for inter-city/ international travel Traffic demand at multimodal interchanges	Long-term
	16. Increase in interoperable rail infrastructure on the TEN.	- % of train km with compatible power supply, signalling, track gauge, loading gauge (clearance), axle weight limit.	Percentage of TEN rail network with interoperable infrastructure standards, interoperability	Short-term

	Objective	Performance Indicator	Description	Applicability*
Accessibility	17- Increase quality of surface connection of major airports	- Demand/Capacity measures for road and rail links to airports - Average travel time from airport to city centre by rail, bus & car - Public transport frequency from airport	Quality of road/rail connections to airports	Short-term
	18. Minimise constraints in trip making and increase service availability to population	- Accessibility Index - Km/population or area	Network size per population, composite accessibility index of population	Long-term, requires periodical studies to estimate accessibility indices
	19. Improve connectivity to island areas	- Demand/capacity measure of air and maritime links to island areas	Quality of air and maritime connections to island areas Quality of land connections to ports (road and rail access, speed & reliability of interchange) Overall travel times/speeds/ frequencies from major cities to islands by land/sea and by air	Short-term

	Objective	Performance Indicator	Description	Applicability*
Economic Viability	20. Accommodate increases in demand (through capacity enhancement and modal shift along corridors)	- Forecast volume/capacity by mode along corridor	Traffic demand forecasts by mode along corridors, modal capacity along corridors, investment	Short-term, requires forecasting studies
	21. Ensuring fair and efficient infrastructure user charges	- % of cost recovery	Level of recovery of social marginal costs through user charges per mode, for freight/passenger traffic	Short-term
Environment	22. Decrease atmospheric pollution around TEN links (Better achieved by modal balance and reducing bottlenecks)	- Kg. of emissions per vehicle-km by major link	Amount of emissions at major links	Short-term
	23. Reduce energy consumption and CO_2 emissions at network-level	- Million tonnes of oil equivalent (Mtoe) per equivalent transport unit (etu) by mode - Tonnes of annual CO_2 emissions	Energy consumption, per etu by mode at network Level of CO_2 emissions	Short-term
	24. Mitigate noise effects in TEN corridors	- x population exposed to a specified noise level (L_{dn} dB)	Non-user noise exposure to above 50, 60, and 65 dBA around major transport infrastructures	Long-term

	Objective	Performance Indicator	Description	Applicability*
	25. Minimise effects of transport in environmentally sensitive areas	- Km. passing through natural protected areas	Extent of TEN crossing natural protected areas under Directive 92/49/EC	Short-term
Modal Balance	26. Increase market shares of non-road modes to a competitive level shifts in selected Corridors/Areas	- Market share of non-roads per corridor	Traffic demand by mode, capacity, terminal utilisation, investment per corridor	Short-term
	27. Revitalise passenger demand for railways, rail access to airports, and modal split with air travel	- Annual passengers-km/passenger seat-km - Change in passenger demand over previous years - Travel distance and travel time on corridors for rail and air	Passenger load factors, demand Travel time/distance on corridors	Short-term
	28. Encourage long distance freight market share for railways and waterways	- Annual tonne-km by rail or waterways/total freight demand for distance > X Km - Volume/line capacity - Number of operating days on waterways	Km of TEN where modal split less than target % for distance > X km freight Inland waterway availability	Short-term

8. Application examples

The research study included several case studies in order to demonstrate the use of the indicators proposed using real data. The aims of these case studies were firstly to test the availability and robustness of data required for the indicators and secondly to test the use of the indicators themselves, providing feedback on their applicability and utility.

In this paper, a **TEN-T European case study** is presented, concentrating on using the set of performance indicators to identify bottlenecks and other level of service issues on the Trans-European road and rail networks. This study made use only of data available in the European Commission's **GISCO** TREN database (Eurostat, 2000). Performance Indicators depicting the utilisation of supply, i.e., capacity bottlenecks, using demand and capacity indicators for road and rail networks were selected.

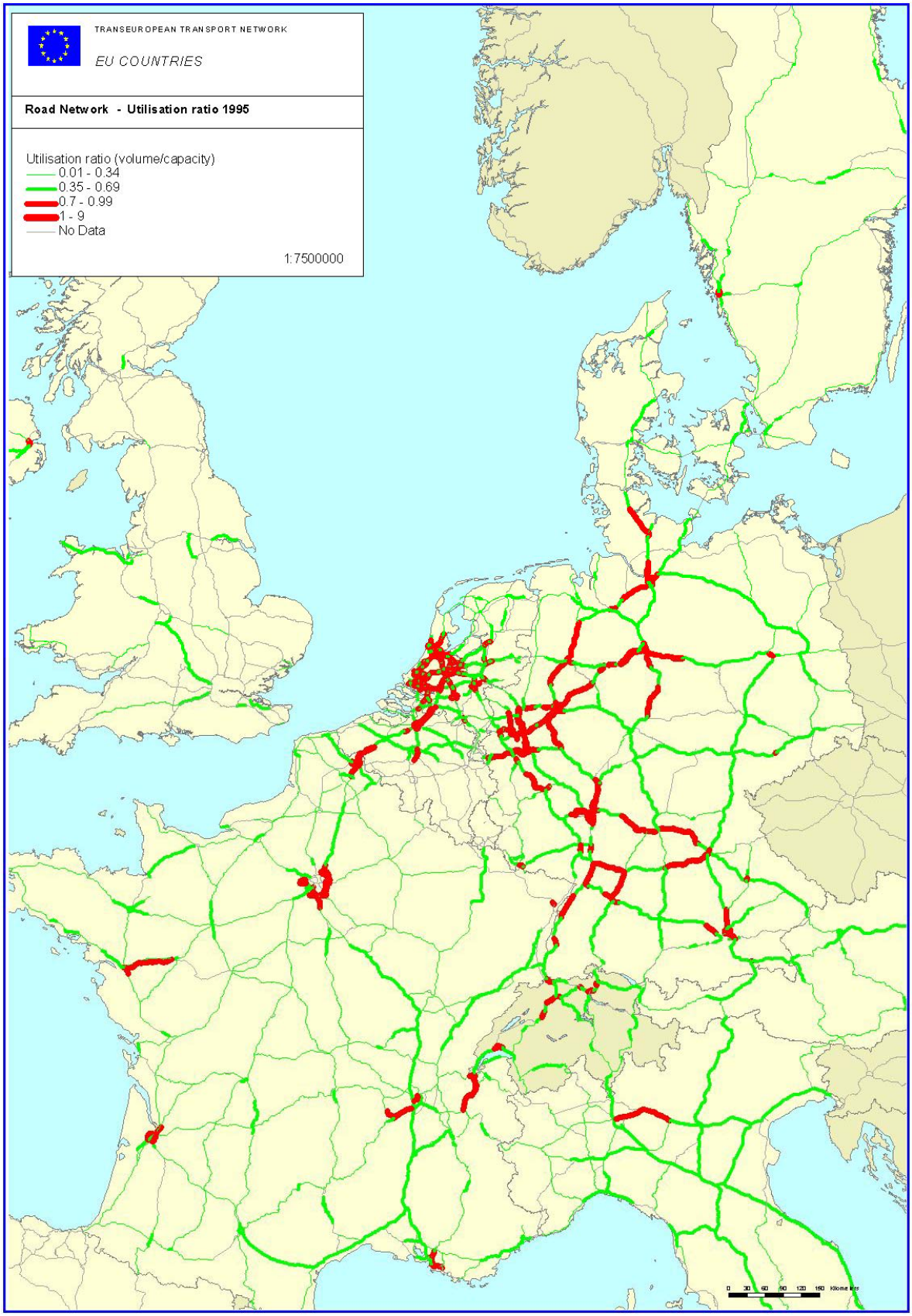
Figure 3 shows the utilisation of capacity in terms of total traffic volumes on the TEN-T road network (a weighted combination of lights and heavies) divided by total capacity (based on the number of lanes). An important factor in assessing service level indicators is the need to consider modal shifts as a possibility. In the road sector for example, capacity bottlenecks can be seen in a somewhat less negative light, if coupled with policies to shift excess demand to environmentally friendly modes.

Figure 4 shows an illustration of the utilisation of the line capacity for the Trans-European Rail Network. Two railway links can have very different capacities due to topography, junctions, mix of passenger trains and freight trains. It should be noted that because of deficient information on daily freight-volumes, the utilisation ratio for many segments of the European railway network could not be calculated. For both figures, the utilisation ratios have to be seen as a demonstration of the potential data with no consistent European-wide benchmarks for capacities or level of services, and the values obtained are only examples.

Other possible service level indicators from the initial list of Performance Indicators proposed were not suitable or could not be calculated due to absence of information on the DG-TREN database or non-harmonised definitions of the data sets between the various countries. In many cases there is no EU standard to pinpoint threshold values. It is therefore difficult to conclude on whether a certain indicator value constitutes a service level deficiency or not.

Key lessons learned from the case studies are that for the short-term estimation of indicators, the availability of data (particularly on a link or corridor level or on a regional/local authority level), and the consistency of data between different countries (and even between different regions or transport operators within the same country) are of crucial importance. This issue somewhat limits the number of indicators that can be used at a European level and justifies the use of a simple pragmatic approach in the short term.

In addition, a lesson from the case studies has been that the Performance Indicators needed to be more precisely detailed in terms of what data is measured, on what scale, using what units and what definitions. In the medium term, in order to obtain harmonised data, the EC needs to be more prescriptive and set down **minimum data standards and benchmarks** for the various Performance Indicators.



/Source of traffic volumes: E-Road traffic census from UNECE, 1995)

Figure 3: Utilisation of Road Capacity on the Trans-European Road Network
(Demand / Capacity, data from DG TREN GISCO Database)

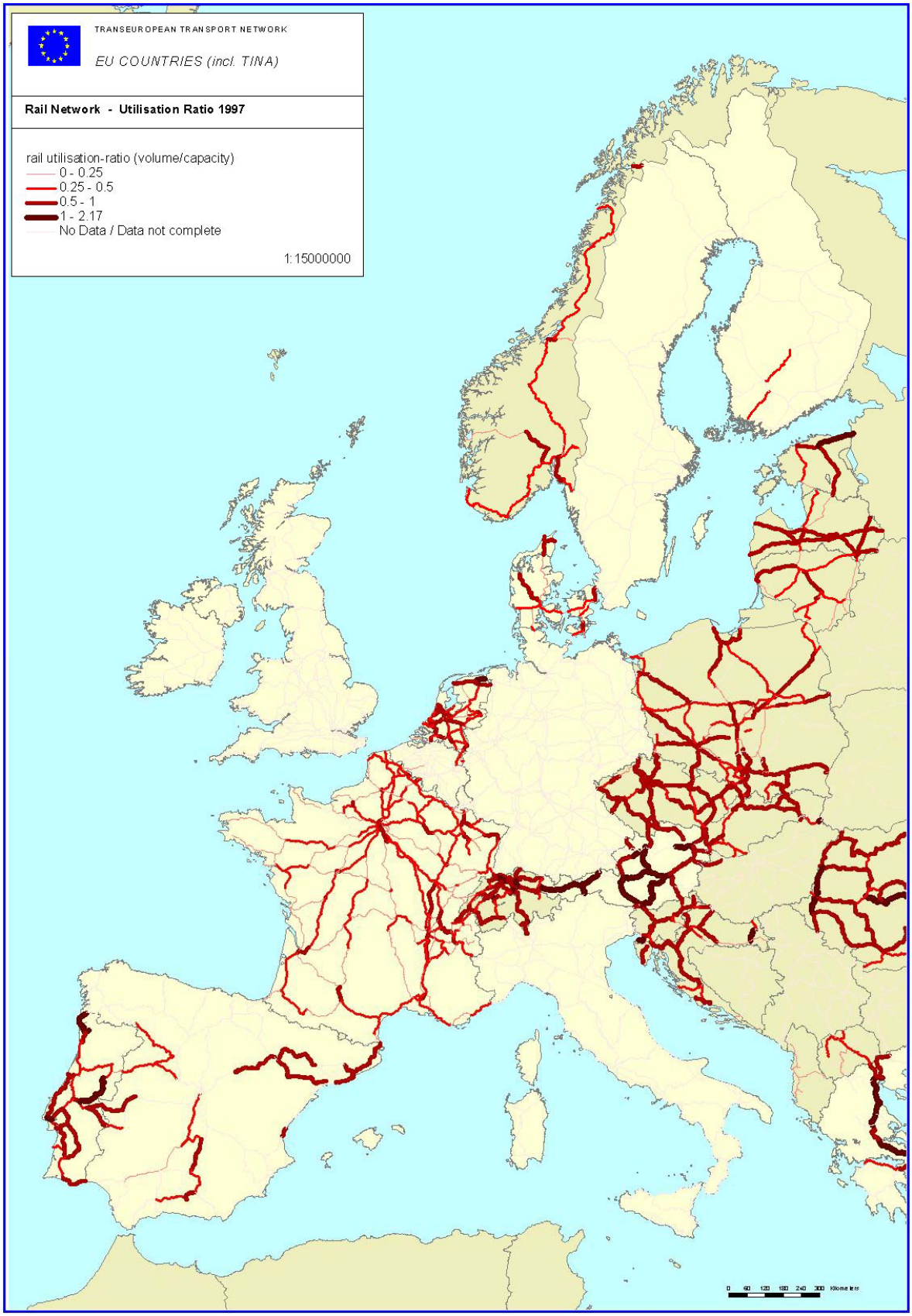


Figure 4: Utilisation of Rail Capacity on the Trans-European Rail Network
(data from the DG TREN GISCO Database)

9. Recommendations for applying the performance monitoring framework

Development of performance indicators is not a single 'snapshot' exercise. The Commission should adopt plans for the **continuous** update, refinement, and development of performance indicators. Regular updates of the indicators coupled with the development of more intricate and sophisticated levels of performance indicators, as data availability (particularly among Candidate Countries) improves, should be a priority. As the European policies and guidelines evolve and with the proposal of a major revision of the guidelines by 2004, the emphasis would be more in adopting intricate performance indicators to provide support. The importance of continuing close co-operation between European entities and organisations (in particular DG TREN and Eurostat), and Member States and Candidate Countries for Accession should be emphasised.

On the basis of the findings, the following steps are envisioned as a follow-up or a road map to apply and implement a consistent and harmonised trans-European monitoring framework. Figure 5 provides an overview of the recommended framework for the development and application of Performance Indicators.

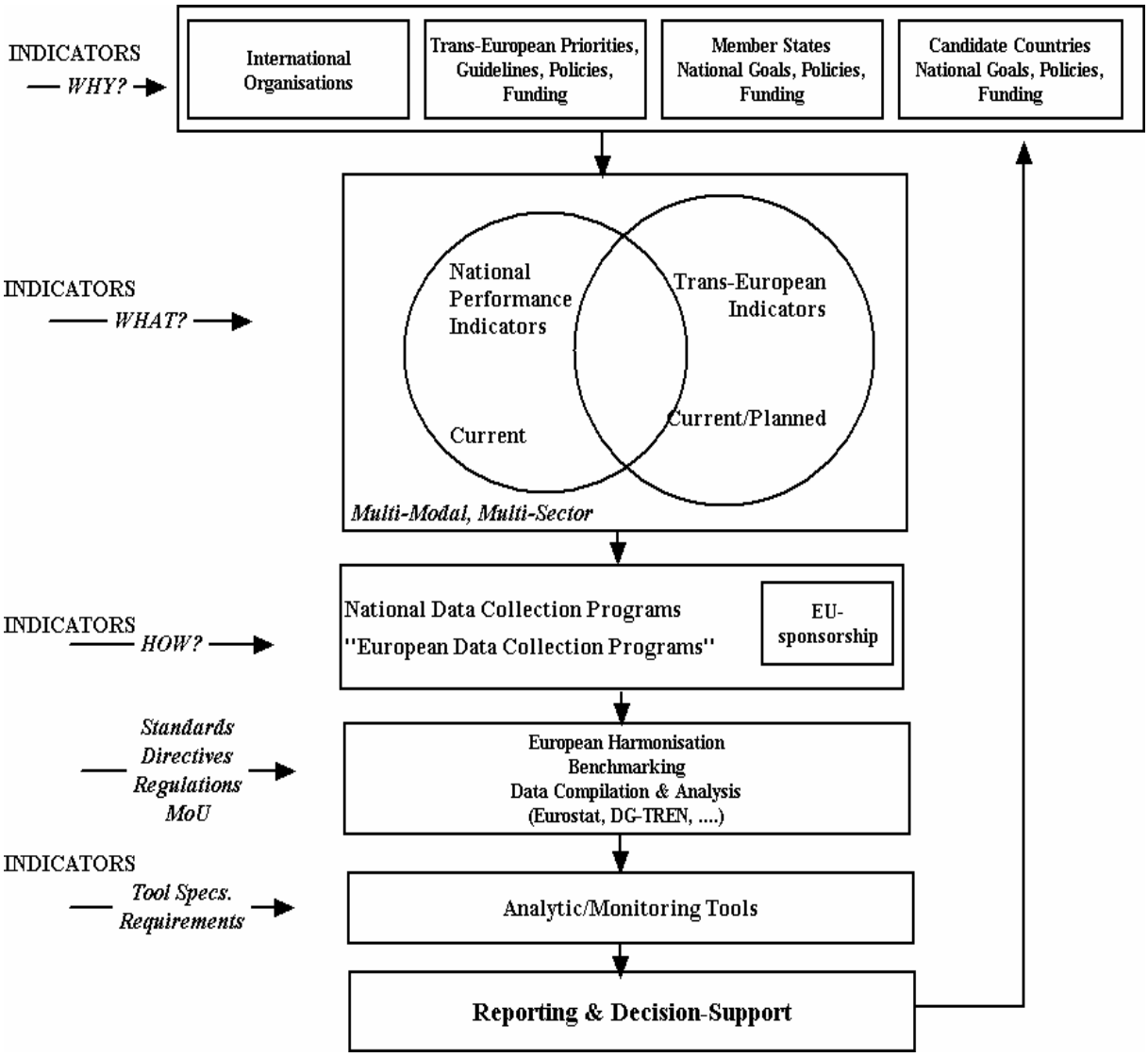


Figure 5: Recommended Approach for Performance Indicators Application

- **Data collection and standardisation**

Minimum quality levels should be defined for the actual collection of the data in order to make data reliable and comparable. Definition of the quality of data-collection for the various indicators falls outside the scope of this project but needs serious attention. In cases where national authorities differ in the interpretation and estimation of performance indicators, despite the existence of available data, efforts should be made by international organisations and/or Eurostat to achieve a degree of standardisation in the development and estimation of indicators. Good examples of such indicators include road capacity values, traffic volume thresholds, infrastructure categorisations and so on.

Performance indicators identified by the research, but not adopted due to data unavailability or lack of harmonised definitions, should be accelerated and pushed forward for adoption and data collection by the Member States. It is also necessary to regularly review the performance indicators to add on to evolving priorities and monitoring schemes.

- **Pilot survey of TEN-T applying the performance indicators and supporting data**

National authorities in Member States and Candidate Countries for Accession should carefully review the identified lists of indicators and provide a critical assessment on the time period for adoption and use of each indicator in question. A pilot survey on Member States and Accession Countries to collect the data on the TEN-T and TINA networks is necessary for the estimation and validation of the recommended performance indicators. Short-term indicators with high data availability can be the basis for the pilot surveys.

A proposal might be that the survey could focus, at least in the initial stage, on a selected group of high-priority international corridors, according to certain criteria.
Interested delegates of the TEN-T Committee could start to work immediately to carry out such pilot surveys. The results can be included in the next implementation report under Article 18 of the Guidelines. At the light of the results, provisions for regular comprehensive surveys could be integrated in the next revision of the TEN-T Guidelines. In all stages, Eurostat would play a vital role in organising the work in conjunction with DG TREN.

A project, under the European Union research Framework Programmes, is currently underway to develop the European Transport Policy Information System (ETIS) (NEA, 2004). This system will provide policy-makers and policy analysts with the capability to include the European dimension in monitoring and analysing developments in European transport related strategic issues concerning infrastructure investments, forecasts, projects and policy impact assessments. The European Transport Information System will use the Trans-European Networks-Transport (TEN-T) as the basis for a pilot.

- **Specification of concrete target statements for trans-European transport policy**

The lack of specific target statements related to the current TEN-T Guidelines can be a source of vagueness and non-specificity of performance measures to measure the degree of relevance of investments and projects to the trans-European policies. The development of specific target statements and objectives entails extensive consensus-reaching activities of the Commission with the Member States. This is necessary in order to reach a set of evolving target statements that can be used to provide clarity and substance to the general objectives, and to facilitate a consistent approach to meeting them. For the short-term, several interim target statements can be proposed by the TEN-T Committee to test the applicability of the proposed framework.

- **Refinement and development of the performance indicators framework**

On the basis of the above work, the framework developed in this research can be fine-tuned and updated to reflect the current status of priorities (through target statements) and data availability (through the pilot survey) for adoption as TEN-T reporting framework within the short-term (2-3 years).

International and European organisations such as Eurostat, OECD, UN/ECE, PIARC, ECMT and UIC should be closely involved in the harmonisation work, in co-ordination with current data collection activities which take place under their auspices.

The current DG TREN database should be expanded, or one new separate database should be implemented in relation to the performance indicators framework developed. The new database system should be an external multi-user relational database management system in order to support complex spatial queries and efficient data retrieval and database management. Users should have easy access to the required data by custom designed database access features within the GIS system.

On the basis of the interim target statements proposed, benchmarks to measure and compare the degree of attainment of the various sections of the TEN-T to the relevant objectives can be developed. International standards and target measures used by international organisations and national authorities can be used as a basis for comparison.

- **Inclusion of the Performance Indicators Monitoring Mechanism within the future revision of the TEN-T Guidelines**

As part of the major revision of the TEN-T Guidelines planned by the Commission in 2004, the framework of using performance indicators to monitor the development and status of the TEN-T multi-modal network (including Accession Countries) should be part of the Article requiring Member States to report regularly on the status of their infrastructure. The goals of the TEN-T transport network are not significantly different from the ultimate goals of transport policy in Candidate Countries for Accession. The Transport Infrastructure Needs Assessment project (TINA, 1999), under the auspices of the Commission has produced schemes for the development of road, rail and inland waterway networks for extending the TEN-T to the Accession Countries. The selection of performance indicators for use at Candidate Countries is essentially the same as EU countries. The restructuring of the transport sectors in most Candidate Countries for Accession seem to lag behind the development of the transport sector in EU countries. Thus, these countries have an even greater need for a more precise definition of transport networks and performance targets at the short- and long-term scales so that scarce funding should be used as efficiently as possible. In the short-term, infrastructure investments to extend and improve the quality of the networks in the Accession Countries seem to be the priority. Specific provisions can be made for Accession Countries, for example an interim period, to allow for the development and set-up of data reporting resources.

10. Conclusions

Performance monitoring of the trans-European transport network is essential to provide a harmonised and consistent view of the requirements and status of the network. This paper provides an overview of the work approach and the output developed in order to set-up a consistent and permanent performance monitoring mechanism for the trans-European transport network. The paper presents the output to develop network-based performance indicators that are based upon a detailed survey of the requirements and constraints of both national authorities in the Member States and Accession countries on one hand and the European Commission requirements for seamless traffic along the trans-European

networks. Recommendations for the adoption and application of the performance indicators developed for project appraisal and network monitoring are provided.

Acknowledgment

This paper builds on the analysis of large amounts of data, studies and reports. The author would like to acknowledge the guidance and input of the European Commission-Directorate General for Transport and Energy for steering and concluding this work, within the EC-funded INDICATORS project. Special recognition goes to the Transport Research Laboratory of the United Kingdom, DHV of the Netherlands, Dorsch Consult of Germany and ISIS of France for their co-operation in the project. Finally, the author would like to acknowledge the useful information and creative ideas provided by the various authorities and organisations consulted, in particular the CEDR (Conference of European Directors of Roads), Eurostat, the United Nations Economic Commission for Europe and the national authorities in all EU Member States and Accession countries for providing their input and validation of the work.

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(All TEN-T related guidelines and regulations can be downloaded on the DG-TREN website: http://europa.eu.int/comm/ten/transport/index_en.htm)

Glossary

DG TREN	EC Directorate-General for Energy and Transport
EC	European Commission
ECMT	European Conference of Ministers of Transport
EEA	European Environment Agency
EFTA	European Free Trade Association
EIB	European Investment Bank
EU	European Union
Eurostat	Statistical Office of the European Communities
etu	equivalent transport unit
GISCO	Geographical Information System for the Commission
OECD	Organisation for Economic Co-operation and Development
PIARC	World Road Association
TEN-T	Trans-European Networks for Transport
TERM	Transport and Environment Reporting Mechanism
TEU	Twenty-foot Equivalent Unit
TINA	Transport Infrastructure Needs Assessment Report- (Network for Accession Countries)
UIC	Union Internationale des Chemins de Fer (International Union of Railways)
UN-ECE	United Nations Economic Commission for Europe
WERD	Western European Road Directors