PERFORMANCE INDICATORS FOR THE TRANSEUROPEAN ROAD NETWORK

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Abstract

In 1996 the European Parliament and the European Council approved Guidelines for the development of a Trans-European Transport Network (TEN-T) (EU-Commission, 1996). Managing and planning of TERN requires Performance Indicators as bases to enable its monitoring and regular reporting on the implementation of EU-Commissions' decisions and the needs of revision.

Furtheron there is a wish to undertake benchmarking for which indicators are also necessary. Benchmarking in the sense of international comparison has for the WERD (Club of West European Road Directors) the function of learning from experiences of other countries.

As a generally accepted definition of Perfomance Indicators does not exist SG TERN (Subgroup TERN set up by WERD) has suggested that Performance Indicators related to roads are quantifiable attributes used at national and trans-European levels to describe the performance of policy actions/decisions, management of road networks and road traffic, funding and general impacts of the road transport system.

By limiting the present work to the national road transport systems and in particular the TERN there may be the views of stakeholders to be considered. They may have different, sometimes overlapping and conflicting objectives. These stakeholders are:

- the Council (of transport ministers), the European Parliament, the Commission, and national governments/ministries,
- the national road administrations
- the road users and the freight using industry/business
- the neighbours to the roads.

It is distinguished between the following 2 levels of indicators:

- general, descriptive road transport related indicators, most often related to the entire society (country) or to the entire public road network
- indicators related to single sections of national road networks and TERN and linked to more specific objectives of EU-policies, management by national road administrations, services to road users and industry/business.

Indicators related to EU-policies are derived from policy objectives expressed in the Guidelines for TEN-T and the White Paper on Transport policy 2010. Indicators for management and services are developed from appropriate objectives already used in some EU-Member States.

Developing, implementing and making use of performance indicators should be understood as a permanent process. New policies, demands, management methods, monitoring equipment etc. will at all times require careful considerations as to include future performance indicators and their related data and measurements. For that reason it should be followed the experience as described, developments as they occur from studies of e.g. PIARC and the use of performance indicators in other parts of the industrial world.

Key Words

PERFORMANCE INDICATORS, PARAMETERS, MONITORING TOOLS, PLANNING, TOOLS, BENCHMARKING

1. INTRODUCTION

1.1 Objectives

Several developments urged the Western European Road Directors (WERD) to look for a coherent way of describing the performance of their national road network and more especially the Trans-European Road Network (TERN).

1. In 1996 the European Parliament and the European Council approved Guidelines for the development of a Trans-European Transport Network (TEN-T). Every two years an report (Implementation Report) should describe the implementation of decisions and a Revision Report should every 5 years report whether the Guidelines should require revision. For the road sector this means that Member States are requested to deliver data describing the performance of TERN understood as the infrastructure, its traffic and the consequences thereof including investments.
2. Managing and planning the future development of the national road network – including TERN - is another reason to develop performance indicators with a view to make a transparent evaluation of the network as it functions at present and as it will function in a planning horizon of 20 years. The latter can be examined by a series of "feed-back processes" at international level for which SG TERN developed a "2020 model" (see Figure 2, chapter 5).
3. Finally there is a wish to be able to undertake benchmarking for which indicators are also necessary. Benchmarking in the sense of international comparison has for the WERD the function of learning from experiences of other countries.

1.2 Definition

A generally accepted definition of Perfomance Indicators does not exist. For the present work SG TERN suggests the following definition to be applied:

Performance indicators related to roads are those quantifiable attributes used at national and trans-European level to describe and measure the performance of policy actions/decisions, management of road networks and road traffic, funding and general impacts of the road transport system.

1.3 Recent developments

A first international attempt to deal with performance indicators for the road sector were taken by OECD which undertook to develop an integrated system of indicators (OECD 1997 and 2000) later to be followed by a report by PIARC in 1999. In 1999 WERD, through SG TERN, took first steps to develop a system of indicators for TERN based on experience from providing data for the first Implementation Report and the above reports from OECD and PIARC.

In 2001 the Commission in the White Paper on Transport Policy described plans for a monitoring system of transport policy and later that year commissioned a project too develop performance indicators for TEN-T. The report was published in November 2002 (EU-Commission, 2002) and has been considered by SG TERN besides providing yet another back-

ground for the present work of SG TERN.

1.4 The present paper

This paper presents the results of the work by SG-TERN over the last 3 years to identify significant indicators for TERN and national road networks. Being aware that finding appropriate up-to-date performance indicators is a permanent process in the long run the framework for the work is presented in short form, in oder to give incentives for further international co-operation in this field.

2. GENERAL VIEWS

2.1 Stakeholders

By limiting the present work to the national road transport systems and in particular the TERN there may be 5 stakeholders to be considered. They may have overlapping and different objectives as well as conflicting objectives. The stakeholders are:

- the Council (of transport ministers), the European Parliament, the Commission, and national governments/ministries
- the national road administrations
- the road users and the freight using industry/business
- the neighbours to the roads.

The tasks of the EU stakeholders are to seek assurance that the policies of TEN-T are indeed implemented and that long term investments are planned and carried out in accordance with the Guidelines.

The objectives of national governments basically might bet he same as for the Council of ministers but may be extended to also include country specific objectives and targets.

The tasks of national road administrations are to efficiently execute the politically intended action plans of infrastructure development, maintenance, operation, traffic management and information. The national road administrations also need to take into consideration policies towards and wishes of the road users i.e. those driving cars, trucks, busses besides the more vulnerable road users as cyclists and pedestrians. The needs of the industry being dependent on good road transport adds to the tasks of the national road administrations. Finally the neighbours along the road network have environmental problems derived from road transport and which must be dealt with.

2.2 Levels of Indicators

Performance indicators are in this work by SG TERN limited to the following 2 levels:

- general, descriptive road transport related indicators, most often related to the entire society (country) or to the entire public road network,
- performance indicators related to single sections of national road networks and TERN and linked to more specific objectives of EU-policies, management by national road administrations, services to road users and industry/business as well as services to road neighbours

Although SG TERN has at this stage limited its considerations to TERN, it is assumed that the indicators suggested may also be used for national and regional policies and road networks.

2.3 Development of indicators

Indicators related to EU-policies are derived from general policies expressed in the Guidelines for TEN-T and the White Paper on Transport policy 2010. These policies are "translated" into general objectives for TEN-T and further transformed into more specific objectives for TERN. The specific objectives are subsequently described in the form of indicators that again are described in the form of measurable parameters.

EU-policies

- The policy objectives in the Guidelines and in the White paper appear to vary in level of abstraction: some objectives are very broad and general, other are very specific (e.g. from “a smooth internal market” to specific characteristics of the road network such as "the avoidance of border restraints" and “a list of 14 projects”). Objectives also appear to be interrelated. One objective can be a policy measure to realise another objective. E.g. network objectives can be a policy measure for more general policy objectives such as those concerning the internal market. Also policy objectives can overlap, e.g. sustainable mobility implies not only mobility objectives, but also environmental objectives. Furthermore in many cases no definitions of policy objectives are formulated.
- Policy objectives sometimes also conflict with each other, e.g. increasing speed and increasing noise.
- In many cases it is not clear how indicators are derived from policy objectives as described in the Guidelines or in the White Paper. The identification and explication of intermediate objectives can help to clarify and underpin the relationships between more general or more specific objectives and indicators.

Management and Services

Indicators for management by the national road networks and services to road users and neighbours are developed from objectives already used in some EU-member states and have been agreed upon by SG TERN. Those objectives are described in the form of indicators that again are described in the form of measurable parameters.

As seen from the above, there are no generally agreed objectives for management of a road administration nor services to road users and neighbours. In simple terms road administrators have the objectives:

- aiming to realise national and EU policy objectives
- aiming to accommodate demands of users and neighbours and
- use of means (assets and budgets) to achieve national, EU and user objectives effectively and efficiently.

A detailed description of how to realise these objectives is presented in chapter 5.

3. INDICATORS DERIVED FROM EU- AND NATIONAL POLICIES

From the Guidelines of 1996 the preconditions of the TEN-T as well as the proper articles of the Guidelines specify conditions and objectives of the TEN-T.

The preconditions include statements on how TEN-T should contribute to higher goals of the EU: TEN-T should contribute to

- a smooth functioning of the internal markets
- strengthening of economic and social cohesion

- ensure sustainable mobility of persons and goods under the best possible social, environmental and safety conditions
- integrating all modes of transport (multi-modality)

In the proper articles there are two which specifies general objectives of TEN-T (article 2) and specific characteristics of the road network (article 9) respectively.

Article 2 states that the network must

- ensure the sustainable mobility of persons and goods within an area without internal frontiers under the best possible social and safety conditions, while helping to achieve the Community's objectives, particularly in regard to the environment and competitions, and contribute to strengthening economic and social conditions
- offer users high quality infrastructure on acceptable economic terms
- be, insofar as possible, economically viable
- be capable of being connected to EFTA and Central and Eastern Europe and Mediterranean countries

Article 9 states that the road network shall

- guarantee users a high, uniform and continuous level of service, comfort and safety
- include infrastructure for traffic management and user information, based on active co-operation between traffic management systems at European, national and regional level.

SG-TERN has chosen to distinguish between the general EU policies referred to in the Guidelines and the specific policies related to transport. SG TERN has further - as mentioned in section 2.3 - been seeking to link the two in the attempt to derive at proper indicators.

Based on the above and seen from a highway administration management point of view (good overview and understandable terminology and actions) SG TERN has initially tried to find out to performance indicators for

- mobility (traffic demand of persons and goods)
- safety of transport
- environmental protection
- economic viability

and under these headings deal with the above policies anticipated to cover EU and national government policies.

Under the heading of „Mobility“ the following policies apply:

- smooth functioning of the internal market incl. promotion of competition
- strengthening of economic and social cohesion of the Union
- ensure interoperability of systems
- ensure and improve multimodality
- offer high quality infrastructure

Under the heading of „Safety“ the following apply:

- offer best possible safety conditions and
- high quality infrastructure

Under the heading of „Environment“ the following apply:

- ensure sustainable mobility of persons and goods as well as
- protection of the environment

Under the heading of „Economic viability“ the following apply:

- be, insofar as possible, economical viable and
- strengthening economic conditions.

Table 1 shows for each of the above 4 headings the link from general EU policies to objectives of transport policies and further to objectives of TERN, the latter being the suggested indicators for the 4 policy headings. These indicators are to be quantified by measurable parameters, a topic to be dealt with in chapter 6.

Table 1 : From EU and national policies to TERN indicators

Policy objectives >	**Transport Objectives >**	**TERN objectives >**	**Indicators**
MOBILITY			
Smooth internal market	* ensure mobility for persons and goods * short travel time * reliable journey	- satisfy road transport demand - reliable, appropriate travel speed - reliable, updated traffic information	* Amount of traffic and transport * Speed of traffic at and off peak * Vehicle hours of delay * Congestion hours
Strengthen economic and social cohesion	* provide accessibility between urban and remote areas	- reduction of detours - avoidance of border restraints	* connectivity of TERN network * Accessibility to TERN network
Promote intermodality	* ensure intermodality * ensure interoperability	- links from TERN to other modes - No TERN problem	* Amount of inter-modal exchange at terminals
SAFETY			
Safety and security	* safe travel * secure travel	- reduction of black spots - ensure sufficient level of skid resistance - provision of light and policing	* Fatalities * Accidents * Skid resistance * Lighting * Policing
ENVIRONMENT			
Sustainable environment	* Reduction of emissions * Reduction of noise * Good air quality	- reduction of detours - provision of noise barriers	* Emissions of CO2 and NO2 * Population exposed to unacceptable noise levels * Urban air standard
ECONOMIY			
Economic viability Affordable price of transport	* investments planned * consumptions planned * user costs	- investments on TERN - consumptions on TERN - user costs at TERN	* Road length com - pleted * high level of M&O * Road charges

The following comments to Table 1 may be useful:

Smooth internal market and strengthening economic and social cohesion can be promoted by making transport (or „Mobility“) within the EU more efficient. It is generally accepted that most important characteristics of efficient transport are: low resp. reliable travel time, comfort and costs. The TERN can contribute to an efficient transport by three main characteristics:

- well operating traffic flow on the entire road network with spezial effects on the TERN,
- connectivity of and accessibility to the TERN network (functionality of the network) (Müller, Schacke, 2002)
- good and efficient intermodal links (Müller, Schacke, 2002).

Efficient road transport require optimal and reliable travel times as well as good connectivity and accessibility. Good connectivity and accessibility contribute to the political objective „Mobility“ indicating whether and in which quality transportation the demand of persons and goods between all regions of Europe is met. The kilometrage of persons and goods can be used as an indicator reflecting the demand for transport of persons and goods (basic mobility).

„Multimodality“ is a characteristic of transport and can be defined as integration of modes of transport in such a way that all modes profit from each other (e.g. by optimal connections between modes) and each mode enjoys full interoperability. Providing Interoperability is not a prevailing task the road sector, but rather the rail and sea sectors. Multimodality can be considered, therefore, as a mean to realise more general policy objectives such as a better accessibility of urban and remote areas or environmental benefits or more cost-efficient transport. For the description of multimodality the following indicators are proposed:

- the amount of intermodal transfer
- the development of kilometrage per mode
- the amount of new infrastructure realised to stimulate multimodality.

„Safety“ relates not only to traffic safety but also to security of transport. The primary safety policy is to reduce the total number of fatalities and injuries caused by accidents in road (and other modes of) transport. Thus indicators may be „number of fatalities and injuries“ and the „number of accidents“ the latter divided into fatal, injury and material damage only by accidents. Accidents must be related to traffic volume on a particular link. However, there are several other parameters that influence occurrence of accidents such as percentage of lorries, driving behaviour (e.g. speed & alcohol), preventive provisions (like crash barriers). These parameters are not taken into consideration at this time.

„Environmental issues“ are in the transport policy area at present limited to limit values for emissions, air quality and noise. While CO_2 emissions are of great concern, emissions of NOx are not taken into considerations as they are today at a very low level.

Economic issues are considered to inform about investments planned and user costs to pay for the infrastructure.

An analysis of objectives of national policies comparable to that of the objectives of the EU has not been carried out. There is no doubt that national transport policies might differ (perhaps slightly) from the EU policies. Nevertheless, it is assumed that the required information for the EU is also relevant for national policies. It is, therefore, assumed that the indicators of objectives of the EU can also be used for national policies and hence for the national road networks.

4. INDICATORS DERIVED FROM VIEWS OF USERS AND NEIGHBOURS

To develop and maintain optimal services, road administrations should know the wishes and expectations of road users and neighbours to the roads. In this respect users and neighbours of roads can be regarded as follows :

Some are „direct users“ of TERN such as:

- drivers of busses, trucks and cars for business and
- car drivers for private purposes.

Others are „indirect users“ of TERN:

- transport companies (for passengers and freight)
- shippers, private companies.

Persons and organisations affected by TERN, but not as users of TERN:

- people living adjacent to the TERN (neighbours) and
- third parties such as regional authorities which are in charge of local environmental protection.

The demands of „direct users“ of TERN can be summarised as follows: “within a short time from origin to destination”, “predictability of travel time”, “comfort, services, etc.“, “safe”, “secure” and “acceptable costs”. Indicators for these demands are presented in Table 2.

The interests of „indirect users“ are - besides the demands of the direct users - not measured by means of indicators, but are dealt with in other ways (e.g. communication, regulations).

The demands of “neighbours” concern the environment: “noise” and “air quality”.

Table 2 : From users and neighbours views to TERN indicators

Transport objectives >	**TERN objectives >**	**Indicators**
MOBILITY		
Short travel time Reliable journey Accepted level of service/comfort	* Short and reliable travel time on TERN * Travel time to/from TERN * Minimised delay * High availability of service areas * Smooth road surface	* Speed of traffic on TERN at and off peak * Travel time centres to TERN * Availability of “real time” traffic information * Congestion hours per link * Spacing of service areas * Evenness of road
SAFETY		
High level of safety Dynamic traffic information Personal security	* Good rescue service * Reliable information on traffic and weather * Lightning at dangerous spots * Opening hours of service areas * Policing	* Availability of emergency telephones * Average time from alert to treatment * Availability of “real time” traffic information * Lightning at dangerous spots * Opening hours of service areas * Police patrolling
ENVIRONMENT (users)		
Environmental friendly road network	* Reduction of emissions * Reduction of noise	* Emissions of CO2 and N20 * “Silent” pavement i.e. dB(A)
ECONOMY		
Cheap transport	* Acceptable user costs	* Road charges
ENVIRONMENT (neighbours)		
Minimum noise Good air quality	* Provision of noise barriers * Provision of “silent” pavement	* dB(A) * Urban air standard

5. INDICATORS DERIVED FROM MANAGEMENT OF ROAD NETWORKS

As mentioned in chapter 2.3 national road administrations have the objectives:

- to realise national and EU policies
- to accommodate demands of road users and neighbours to the roads
- to use their resources (assets and budgets) to achieve national, EU, user, and neighbour objectives efficiently and effectively.

To realise these objectives the following resources (inputs) are at their disposal:

„Assets“ such as

- the existing physical infrastructure

- human resources
- equipment and materials
- data, technologies, systems, partners etc.

„Budgets“

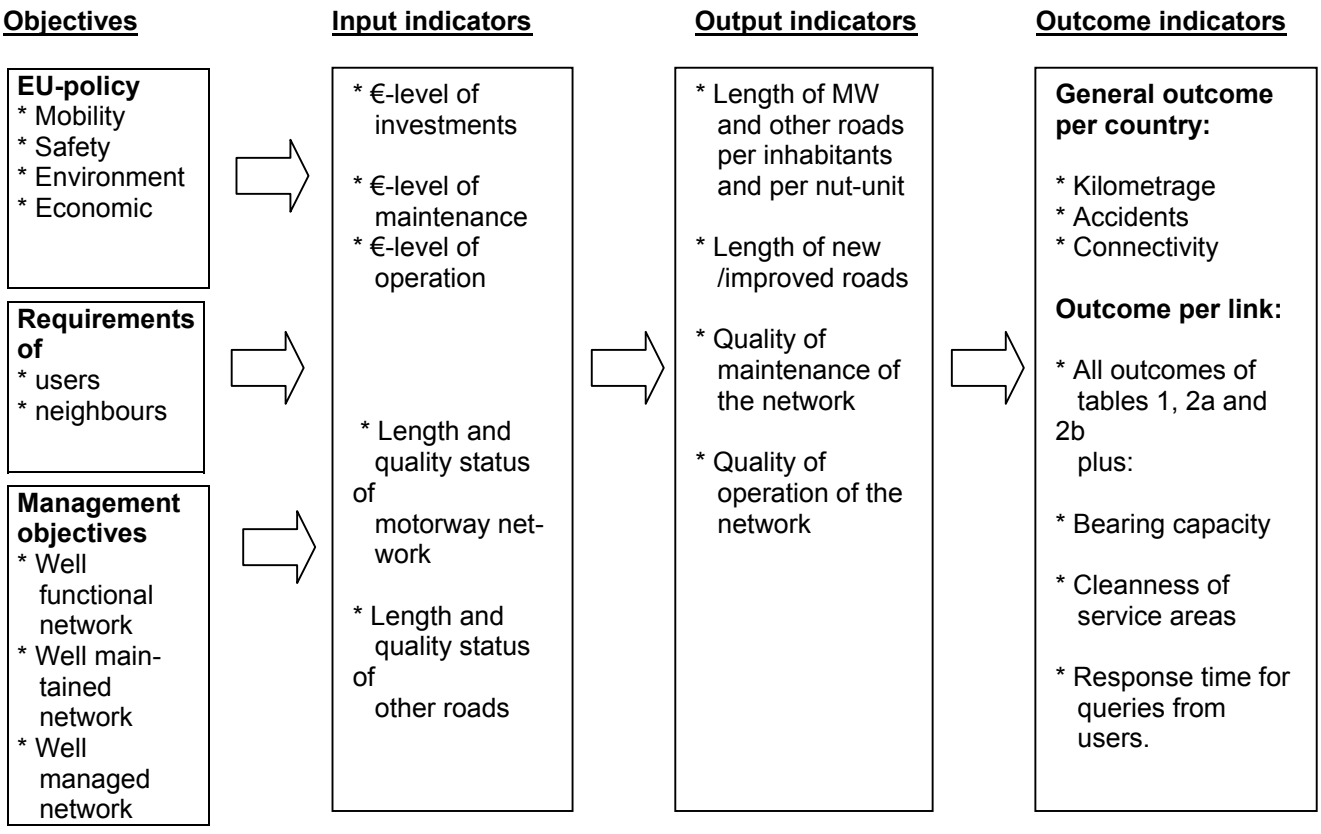
- budgets from national and EC sources.

With respect to the allocation of resources for measures and their temporal effects the following definitions of levels of influence (see Figure 1) should be considered :

- „objectives“ (desired outcomes) of national and EU policies as well as policies related to user and neighbour demands
- „input“ (or means) i.e. assets and budgets necessary to produce planned output
- „output“ such as products and services delivered (roads built or maintained, studies undertaken, user systems improved etc.)
- „outcomes“ (as realised) for the policy objectives (desired outcomes).

Outcomes may have further more long-term foreseeable or not foreseeable „consequences“ for the society. Such consequences most often occur outside the transport system. These consequences are not dealt with any further in this paper.

Figure 1 . Derivation of indicators of TERN for management by road authorities



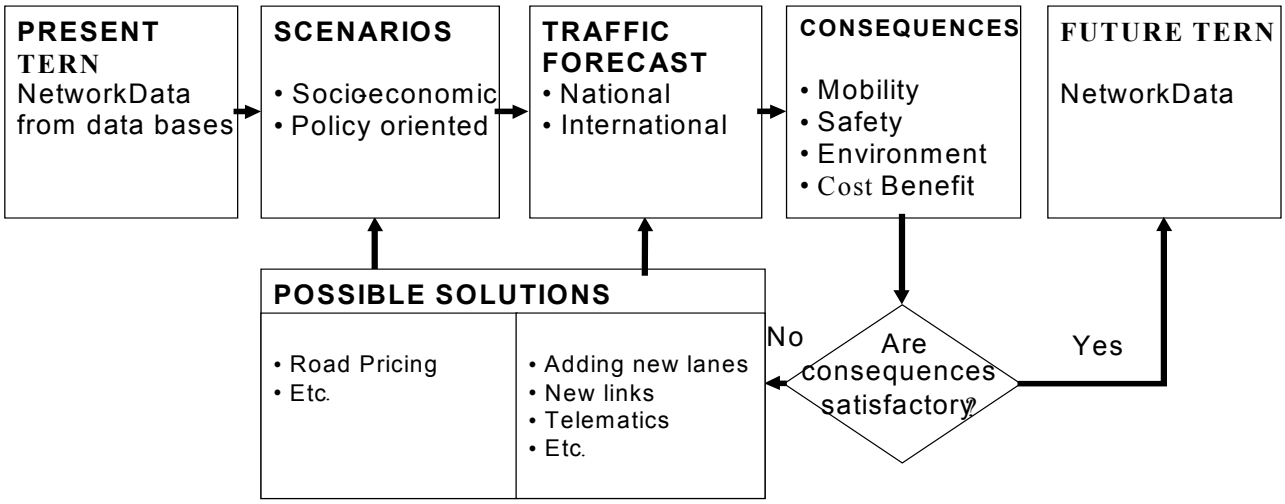
As stated in the Introduction, planning the future development of the national road network and its related services - including TERN - is a main task of the national road administrations. The „2020 model“ (see Figure 2) constitutes a series of actions („feed-back processes“) which aims to achieve a systematic improvements of the road network at TERN level. It covers the preparation of and the process involved in European road traffic forecasting (scenarios and forecasting), the consequences that can be drawn from this forecast situation as well as opportunities to improve the forecast

situation (possible solutions) by modifying the forecast scenario and/or suggesting physical improvements at various links.

This planning process will need performance indicators to show and locally indicate weaknesses and bottlenecks of the physical network and its related services. Appropriate performance indicators for these special quality aspects should describe long term effects as a basis for developments. Indicators to describe the developments may be the average annual daily traffic (AADT) and the kilometrage (pass.xkm and tonxkm).

Benchmarking within a road administration or between road administrations also requires well-defined performance indicators. Performance indicators may also serve for the harmonisation required for international comparisons on road works and costs. Such benchmarkings may serve as a learning process for WERD.

Figure 2 : The „2020 model“



6. DATA FOR INDICATORS

While chapters 3, 4 and 5 have described the links between objectives and indicators the task is now to obtain a firm link between indicators and parameters describing the indicators.

Some indicators from chapters 3,4 and 5 in themselves constitute parameters that are directly measurable. Other indicators need a detailed definition of measurable parameters describing the indicator.

Table 3 lists indicators from Tables 1 and 2 and defines the parameters that describe the indicators. Furthermore Table 3 shows to what extent the parameters are available. Availability may be

- today
- within a short term (3 years) or
- within a longer term (5 years and beyond).

Table 3 : Indicators and their measurable parameters

Indicators	Parameters	Level (time + geography)	Data Availability
1. Amount of traffic	AADT max. No. of vehicles/ hour	at cross-sections at cross-sections	Now
2. Amount of transport	pass. x km. ton x km.	per link/ day per link/ day	Now Now
3. Speed of traffic - at peak hours - off peak hours	 km./hour km./hour	 at cross-sections at cross-sections	 Now Now
4. Congestion hours	Hours lost by speed below limit	Annual hours per link	Short term
5. Vehicle hours of delay	No. of hours with mean speed < 75 km/h.	Annual hours per link	Short term
6. Connectivity of TERN network	Share of TERN open to traffic related to the recent planning period	share of "green" of total TERN per region	Now
7. Accessibility to TERN network	Share of population > 2 hours of driving to TERN	% per cell (NUTS 2)	Short term
8. Amount of intermodal exchange at terminals	No. of pass. and tons to/ from TERN	per terminal/ year	Long term
9. Fatalities	No. of killed	per link/year per country/year	Now Now
10. Accidents	No. of accidents No. of fatal + injury accidents	per link/ year per link/ year	Now Now
11. Skid resistance	Index for skid resistance	per link	Now
12. Lightning	Share of TERN with lightning at dangerous spots	per region	Now
13. Policing	Distance between patrols	per region/ year	Now
14. Emission of CO_2	CO_2	per link/ year	Short term
15. Emission of N_2O	N_2O	per link/ year	Short term
16. Population exposed to certain noise levels	Share of population expo sed to dB>75, 65-75, <65	Noise maps per region	Long term
17. Urban air standard	N_2O, PM10	per link per country	Now
18. length completed	Length completed	km per country	Now
19. Road changes	Average expenditures/ km.	€ per country	Short term
20. Travel time centres to TERN	Time in minutes at speed limits	per link to center	Short term
21. Availability of real time traffic information	Available traffic information via - radio - signing	per link	Short term
22. Spacing of service areas	Average distance between service areas	km TERN/ country	Now
23. Evenness of road	IRI	per link	Short term
24. Emergency telephones	Average distance between emergency telephones	TERN	Now
25. Average time from alert to treatment	Average time	per TERN link per region	Short term
26. Opening hours of service areas	Opening hours	per service area	Now
27. Kilometrage	pass. x km. ton x km.	per country/ year per country/ year	Now Now
28. Accidents	Fatalities No. of accidents No. of fatal + injury accidents	per country/year per country/year per country/year	Now Now Short term
29. Connectivity	Share of TERN open to traffic	share per country/ year	Now
30. Cleanness of service	Hours between cleaning of	per service area	Now

areas	wash rooms		
31. Response time for queries	Average time to produce response	per region	Long term

An issue not yet solved by SG TERN is the accuracy of the data being or to be provided.

7. FUTURE STEPS

Developing, implementing and making use of performance indicators is a process that will not have an end for many years. New policies, demands, expectations, management methods, monitoring equipment etc. will at all times require careful considerations as to why, when, and how to include future performance indicators and their related data and measurements. For that reason it is suggested that SG TERN follows the experience as described, developments as they occur from studies of e.g. PIARC, and use of performance indicators in other parts of the industrial world.

REFERENCES :

EU-Commission, 1996 : European Commission Decision No. 1692/96/ec of the European Parliament and the Council of July 23 1996 on Community Guidelines for the development of the Trans European Transport Network. Official Journal of the European Communities No. L228/1

OECD, 1997 : “Performance indicators for the road sector”; Report prepared by an OECD Scientific Expert Group (IR7), OECD 1997

EU-Commission, 2002 : Indicators – Final Report for the European Commission, DG TREN, 13. November 2002

Müller, F., I. Schacke, 2002 : Towards A European Main Road Network, Routes Roads No. 316, IV – 2002, pp 64 – 73.